RANGE SAFETY MANUAL (RSM-2002)
Rev. A

FOR

GODDARD SPACE FLIGHT CENTER (GSFC)/
WALLOPS FLIGHT FACILITY (WFF)

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WFF Safety Office
Suborbital and Special Orbital Projects Directorate

National Aeronautics and
Space Administration

Goddard Space Flight Center
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FOREWORD

Safety is the responsibility of all National Aeronautic and Space Administration (NASA) personnel, NASA contractors, tenants, experimenters, and range users while conducting operations at NASA Goddard Space Flight Center's (GSFC) Wallops Flight Facility (WFF) or other off-range locations. This requires a concerted effort by all personnel to operate in a manner that will minimize the risks inherent in performing rocket, aircraft, balloon, and associated operations. This document identifies the range safety requirements established by WFF for implementing NPR 8715.5, NASA Range Safety Program, to insure that risks are controlled and minimized.

Safety participation early in the planning stages of a program will reduce the possibility of costly engineering changes and/or scheduling delays. Therefore, coordination with the WFF Safety Office should be established through the WFF Project Manager as early in the planning stages of a project as possible. The WFF Safety Office personnel should be notified of and be represented at technical interchange meetings, preliminary design, system design and critical design reviews, and flight readiness reviews, where ground and flight safety issues are addressed.

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1.0 INTRODUCTION

Purpose

Identify WFF range requirements to implement safety policies and criteria defined in NPR 8715.5, Range Safety Program.

Define specific design requirements, restrictions, operational procedures, and support requirements.

Identify data requirements necessary for WFF to perform appropriate safety analyses and grant approval to conduct operations.

Acquaint range users with the range safety organization at WFF.

Scope

This document is applicable to all programmatic operations and specific aircraft operations conducted at or managed by WFF. It is applicable to all NASA personnel, NASA contractors, tenants, experimenters, and range users. It is the responsibility of all personnel to acquaint themselves with the requirements set forth in this document, NPR 8715.5 and 840-HDBK-0001, WFF Range Users Handbook.

For aircraft operations, this document is applicable for hazardous systems incorporated within or attached to aircraft platforms, operations conducted on the WFF test range, and operations that expose the public to risk greater than that incurred by normal aircraft operations. Aircraft operational requirements for the WFF airfield are defined in 830-PG-7900.0.1, Aircraft Operations Manual.

For WFF managed operations conducted at other ranges, the requirements established by this document shall be used as a minimum unless requirements of the host range are more stringent, in which case the more stringent requirements will apply.

More stringent safety requirements will be considered by WFF if requested by the range users, experimenters, or tenants.

Policy

It is WFF policy to conduct all operations within the risk levels specified in Section 6, Flight Safety. This manual defines the specific requirements, which shall be met to implement this policy.

2.0 RANGE SAFETY ORGANIZATION AND RESPONSIBILITIES

Center Director of Goddard Space Flight Center (GSFC) - Final authority and accountability for all aspects of safety at WFF rest with the Center Director. In order to ensure that appropriate attention is focused on WFF range safety, certain responsibilities are delegated to the Director of Suborbital and Special Orbital Projects Directorate (SSOPD).

Director SSOPD - Responsibilities involving range safety have specifically been delegated to the Director of SSOPD. The Director of SSOPD has established the Safety Office (Code 803) to promote range safety and designated the position of Range Safety Officer (RSO). The Director of SSOPD makes risk management decisions for test range operations when the assessed risk exceeds acceptable levels in accordance with Section 6.2, Risk Criteria. Variances from range safety requirements specified in this manual are dispositioned in accordance with the procedure set forth in 803-PG-8715.1.2, Range Safety Deviation and Waiver Process. The Director of SSOPD has designated the Chief, Safety Office as the Center Range Safety Representative.

Chief, Safety Office - Management responsibility for the implementation of the Range Safety Program rests with the Chief of the Safety Office. The Safety Office Chief supervises the Range Safety Officer and personnel in the Ground Safety Group (GSG) and the Flight Safety Group (FSG) who perform risk analyses, document risk mitigation strategies in Safety Plans, and supervise or implement operational risk mitigation measures. The Safety Office Chief makes risk management decisions for test range operations when the assessed risk exceeds negligible guideline levels in accordance with discretionary guidelines set forth in Section 6.2, Risk Criteria. As designated Center Range Safety Representative, the Safety Office Chief shall work with the NASA Range Safety Manager per NPR 8715.5.

WFF Range Safety Officer (RSO) - The RSO provides range safety policy guidance and direction. The RSO is vested with the engineering authority to certify the design, test, maintenance and use of all elements of the Range Safety System. The RSO acts as the approval authority for Risk Analyses and Safety Plans. The RSO approves safety team member assignments for operations.

Mission Range Safety Officer (MRSO) – The MRSO provides operational oversight of the safety team during operations. The MRSO is given the authority to grant operational deviations from requirements set forth in Ground and Flight Safety Plans where the requirements of 803-PG-8715.1.2 are met. The MRSO implements the measures specified in Safety Plans during test range operations.

Flight Safety Officer (FSO) – For missions utilizing a Flight Termination Systems (FTS), the Flight Safety Officer has the responsibility of implementing flight termination according to the rules established in the Flight Safety Plan.

Program and Project Managers (PM) - Program and Project Manager Safety responsibilities are detailed in NPD 8700.1, NASA Policy for Safety and Mission Success. Additionally, for missions that pose risks above acceptable risk levels, the Program or Project Manager is responsible for preparing and presenting an assessment of circumstances and mission benefits that warrant acceptance of the risks to the Director of SSOPD.

Operations Safety Supervisor (OSS) – The OSS is responsible for supervising all potentially hazardous operations for which he/she has been assigned. The OSS is also responsible for implementation of Ground Safety Plans and operating procedures. In some instances the WFF RSO or designee may delegate this responsibility to other qualified personnel for specific operations. All personnel designated as OSS are certified by the Safety Office through attending an OSS course and participating in OSS testing performed by the GSG.

The responsibility of implementing WFF safety policy, criteria, and planning at ranges other than WFF shall be delegated according to the following hierarchy:

a. The WFF MRSO
b. The WFF Project or Campaign Manager
c. Mission Manager
d. Columbia Scientific Balloon Facility (CSBF) Head of Balloon Operations or designee for CSBF

For the Balloon Program, the Chief, Balloon Program Office shall assure that (1) the requirements and procedures defined in appropriate safety plans and balloon risk analyses are implemented, and (2) the operational responsibilities normally assigned to the MRSO, OSS, or Project Manager in this document are implemented for balloon operations.

3.0 RANGE USERS PRE-ARRIVAL REQUIREMENTS

Range users shall design their systems to conform to the requirements established by this document.

Range users shall prepare and provide to WFF formal documentation pertaining to the project for safety review. This documentation shall include information describing ground and flight systems, operating procedures, and unique requirements of the project. Specific details of the data required are provided in Section 8.0, WFF Safety Data Requirements.

4.0 DEFINITIONS, ACRONYMS AND REFERENCES

4.1 Acronyms:

A/C	Aircraft
ASME	American Society of Mechanical Engineers
AWG	American Wire Gauge
CDI	Capacitive Discharge Ignition
CMS	Contingency Management System
COLA	Collision Avoidance
CRD	Critical Design Review
CSBF	Columbia Scientific Balloon Facility
DOD	Department of Defense
DoT	Department of Transportation
EBW	Exploding Bridgewire
EED	Electro-explosive Device
ELV	Expendable launch Vehicle
ERPG	Emergency Response Planning Guidelines
ESD	Electrostatic Discharge
FAA	Federal Aviation Administration
FACSFAC	Flight Area Control and Surveillance Facility
FMEA	Failure Mode and Effects Analysis
FSG	Flight Safety Group
FSO	Flight Safety Officer
FTS	Flight Termination System
GPS	Global Positioning System
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSG	Ground Safety Group
IFR	Instrument Flight Rules
IIP	Instantaneous Impact Point
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
LBB	Leak-Before-Burst
LOS	Loss of Signal
MAWP	Maximum Allowable Working pressure
MDOP	Maximum Design Operating Pressure
MDP	Maximum Design Pressure
MEOP	Maximum Expected Operating Pressure
MIC	Mission Initiation Conference
MRSO	Mission Range Safety Officer
MSDS	Material Safety Data Sheet
NASA	National Aeronautics and Space Administration
NAWC-AD	Naval Air Warfare Center-Aircraft Division
NLT	No-Later-Than
NOTAMS	Notice to Airmen

NOTMARS	Notice to Mariners
OP	Operating Pressure
OSD	Operation Safety Directive
OSS	Operations Safety Supervisor
P/L	Payload
PDR	Preliminary Design Review
PHA	Preliminary Hazard Analysis
PM	Project Manager
PPE	Personal Protective Equipment
RAR	Risk Analysis Report
RF	Radio Frequency
RLV	Reusable Launch Vehicle
ROA	Range Operations Assistant
RPV	Remotely Piloted Vehicle
RSO	Range Safety Officer
S/A	Safe Arm
SAR	Safety Analysis Report
SDP	Safety Data Plan
SSOPD	Suborbital and Special Orbital Projects Directorate
TD	Test Director
TIM	Technical Interchange Meeting
TM	Telemetry
TNT	Trinitro-toluene
UAV	Uninhabited Aerial Vehicle
USSC	United States Strategic Command
VACAPES	Virginia Capes
VMC	Visual meteorological Conditions
WFF	Wallops Flight Facility

4.2 **Definitions:**

Burst Pressure -- The pressure at which pressure system components undergoing pressurize-to-burst testing rupture or exhibit an unstable fracture.

Burst Factor -- This quantity is equal to the Maximum Allowable Working Pressure (MAWP) divided by the Design Burst Pressure.

Casualty Expectation -- The probabilistic number of casualties due to conduct of a mission or specific period of time or event.

Caution Time -- That time period when any hazardous device or system is present in the hazard area and is in a safe inactive state. When a caution time exists, nonparticipating personnel are allowed to enter the launch area only when authorized by the OSS. Active-essential and standby-essential personnel continue working during a caution time.

Center Essential Personnel – Government or contractor personnel who perform functions necessary for continued operations at WFF or site where WFF has safety authority. For a specific range operation, the Center essential personnel include mission essential personnel (i.e., mission essential is a subset of Center essential).

Collective Risk – The total combined risk to all individuals exposed to a particular hazard during a specified period of time or event (a specific phase of flight).

Contingency Management System – A system designed to manage the vehicle throughout the atmospheric flight envelope that provides a controlled response under the full set of circumstances

defined by the risk assessment. The system may be comprised of a set of elements within the vehicle, including but not limited to manual control, autonomous control, and recovery capability. It may be used as a risk mitigation factor in the risk assessment when applicable.

Danger Area -- That area including impact areas, abort areas, storage areas, or hazard areas resulting from a system malfunction in which the hazards from impacting objects, debris, blast, toxic, etc. exceed the established maximum acceptable risk level.

Danger Time -- That time period when any electrical operations, arming, explosive installation, launching, or other hazardous function is taking place.

Design Burst Pressure -- The pressure is a calculated test pressure that pressurized components shall withstand without rupture to demonstrate its design adequacy in a qualification test. It is equal to the product of the MAWP and a Burst Factor.

Electroexplosive Device -- An electric initiator or other component in which electrical energy is used to cause initiation of explosives contained therein.

Emergency System/Component -- An emergency system component is any system/component, which prevents a hazardous event from occurring or escalating. These systems normally experience very few cycles, but their performance is extremely safety critical. Typical emergency components are relief valves and shut-off valves. Typical emergency systems are fire suppression systems and emergency purge/vent systems.

Flight Hardware – Any hardware that is flown on or is a part of an aircraft, experimental flight vehicle, satellite, lighter than air vehicle, unoccupied aerial vehicle, or space transportation system.

Flight Hazard Area -- The operational area within which the risk due to impacting object(s) may exceed the established risk criteria.

Flight Safety -- A philosophy and methodology whereby rocket, balloon, drone, UAV's and aircraft flight operations can be performed in a reasonable and prudent manner without undue risk to people or property or embarrassment to NASA or the United States Government.

Ground Safety -- Those safety considerations, procedures, and resultant restrictions associated with hazardous systems during storage, handling, prelaunch, launch, and recovery/abort operations, where by operations can be performed in a reasonable and prudent manner without undue risk to people or property or the environment.

Hangfire -- A launch attempt where current to the vehicle initiator was delivered by the firing system and the vehicle failed to ignite as planned.

Impact Area -- The operational area within which one or more objects are predicted to impact in the vicinity of each other.

Individual Risk – The probability of an individual at a specific location suffering a casualty from exposure to a given event during a specific period. Individual risk is typically stated as a Probability of Casualty (P_c).

Inherently Safe -- The predicted trajectory of the vehicle is based solely on the launch dispersion parameters and known system errors.

Instantaneous Impact Point -- The point at which an object would impact if thrusting were stopped at a given time.

Launch Abort -- Premature and abrupt termination of a launch attempt because of existing or imminent degradation of mission success probability or safety requirements.

Launch Area -- The area comprising rocket launching pads, a blockhouse, and auxiliary support facilities.

For airborne launches, it is the defined operational hazard area, which has been obtained from controlling authorities.

Launch Vehicle -- Any rocket, rocket system, or balloon that is used to launch a suborbital or orbital payload, probe, satellite, or other experiment.

Leak-Before-Burst -- A fracture mechanics design concept in which it is shown that any initial flaw shall grow through the wall of the pressure vessel rather than bursting and causing catastrophic failure at the MAWP.

Maximum Allowable Working Pressure --The maximum pressure that a pressure vessel is expected to experience during its service life in association with its applicable operating environments. This pressure is synonymous with Maximum Expected Operating Pressure (MEOP), as it is used and defined in AIAA/ANSI S-080 or AIAA/ANSI S-081.

Maximum Design Pressure -- The system pressure rating based on structural and functional reliability. See also Operating Pressure.

Maximum Expected Operating Pressure -- This term, as defined in AIAA/ANSI S-080 or AIAA/ANSI S-081, is synonymous with MAWP. (See the definition for MAWP, as given above.)

Operating Pressure (OP) -- The pressure a system shall be subjected to during static and dynamic conditions (maximum temperature, maximum relief pressures, maximum regulator pressure, and, where applicable, transient pressure excursions).

Megger Test -- A measurement performed on EED's using a megohmmeter to determine the pin-to-case insulation resistance. The test is performed at a known voltage (normally 500 volts) to verify that the insulation shall not break down and permit EED ignition in this mode.

Misfire -- A launch attempt in which current was not delivered to the vehicle initiator.

Mission Essential Personnel -- Those individuals whose activities contribute directly to the performance of a potentially hazardous operation which is actually under way, and whose presence is mandatory for completion of the operation.

NOTAMS -- An advisory issued to airmen listing restricted or hazardous airspace during certain times.

NOTMARS -- An advisory issued to mariners listing restricted or hazardous areas during certain times.

Power Switching -- Power transfers where the net energy change exceeds 1.5 volts or 10 milliamperes.

Proof Pressure -- The test pressure applied to pressure systems or individual components without failure, leakage, or permanent deformation.

Public -- For the purposes of range safety risk management, all people who are not Center Essential Personnel. Public includes visitors and personnel inside and outside NASA-controlled property who are not Center Essential and who may be on land, on waterborne vessels, or in aircraft.

Range Safety -- Application of safety policies, principles, and techniques to protect the public, workforce, and property from hazards associated with range operations.

System Initiator - Any device that initiates the action of a system. This includes but is not limited to electroexplosive devices, non-explosive initiators, and exploding bridgewire initiators.

TNT Equivalency - The explosive energy per unit mass of the energetic material in question (propellants in our case) divided by the energy per unit mass of Trinitro-toluene (TNT); this number can be expressed as a percentage or a fraction.

Uninhabited Aerial Vehicle – A vehicle that is controlled remotely, or that is autonomous and operates at speeds ranging from subsonic to hypersonic in a manner consistent with a 'conventional' aircraft. A UAV may be launched from the ground or dropped from other aerial vehicles, subscale flight test vehicles, or lifting bodies. A UAV may also be referred to using a different name such as Unmanned Air Vehicle, Unmanned Aerial Vehicle, Remotely Piloted Vehicle (RPV), drones and cruise missiles. Model aircraft (normally vehicles of less than 55 lbs. gross weight flown under manual control within unaided visual contact range) are not considered UAV's.

4.3 **References:**

800-PG-8715.1.1, Unmanned Roadblocks for Hazardous Operations

800-PG-8715.0.2, Training and Certification Procedures for Ordnance Handlers at GSFC/WFF

803-PG-8715.1.2, Range Safety Deviation and Waiver Process

830-PG-7900.0.1, Aircraft Operations Manual (AOM)

840-HDBK-0001, Wallops Flight Facility Range User Handbook

GPR 8719.1, Certification and Recertification of Lifting Devices and Equipment

GPR 1860.3, Radio Frequency Radiation Safety

GPR 1860.1, Ionizing Radiation Protection

GPR 1860.2, Laser Radiation Protection

GSFC-6L, Laser Radiation Source Approval

GSFC 23-28L, Laser Radiation Source Questionnaire

GSFC 23-35, Laser Radiation Source – Personnel Approval

NPD 8700.1, NASA Policy for Safety and Mission Success

NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems

NPR 2810.1, Security of Information Technology

NPR 8715.5, Range Safety Program

2002 National Electric Code, Article 500 - Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2

American Industrial Hygiene Association: Emergency Response Planning Guidelines

ANSI/AIAA S-080-1998, Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components

ANSI/AIAA S-081-2000, Space Systems – Composite Overwrapped Pressure Vessels (COPVs)

ANSI Z136.1-2000, Safe Use of Lasers

AFSPCI 91-700, Range Safety Publication Series (replacement of EWR 127-1)

CFR 14, Federal Aviation Administration, Part 101, Moored Balloons, Kites, Unmanned Rockets, and Unmanned Free Balloons

CFR Title 10, Part 19 (Notices, Instructions and Reports to Workers: Inspection and Investigations) and Part 20 (Standards for Protection Against Radiation)

CPIA Publication 394, Hazards of Chemical Rockets and Propellants

Eastern and Western Range (EWR) 127-1, Range Safety Requirements, dtd. October 1997

FACSFAC VACAPES Operating Instruction, 3120.1J

Flight Safety/Range Safety Officer Training Manual for the NASA/GSFC/Wallops Flight Facility

IEEE C95.1-1991, American National Standard Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 30 KHz to 300 GHz

MIL-HDBK-217F, Reliability Prediction of Electronic Equipment

NASA-STD-8719.9, Standard for Lifting Devices and Equipment

NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

NSS 1740.12, Safety Standard for Explosives, Propellants, and Pyrotechnics

Range Commanders Council Standard 319-99 (RCC 319-99) "Flight Termination Systems Commonality Standard "

Range Commanders Council Standard 321-02 (RCC 321-02), Common Risk Criteria for National Test Ranges: Inert Debris

WFF-822-95-001, Geodetic Coordinates Manual, NASA GSFC WFF dtd. January 1995

5.0 GROUND SAFETY

5.1 General

5.1.1 The ground safety goal of GSFC's WFF is to minimize the risks to personnel and property involved in conducting operations at GSFC's WFF and to prevent mishaps that would result in embarrassment to NASA or the United States Government.

5.1.2 It is required that all systems be designed such that a minimum of two independent, unlikely failures shall occur in order to expose personnel to a hazard.

5.2 Hazard Control

5.2.1 Hazard Control Methods

The methods employed by GSFC's WFF to protect personnel and property and to minimize the risk in conducting potentially hazardous operations are:

* Identify all the known hazards associated with the program
* Implement safety design criteria
* Minimize exposure of personnel to hazardous systems

* Establish safe operating procedures

* Plan for contingencies

5.2.2 Exposure Limits

The cardinal principle to be observed in any location or operation involving explosives, severe fire hazards, high pressure systems, or other hazardous materials, shall be to limit the exposure to a minimum number of personnel, to a minimum time, and to a minimum number of potential hazards, consistent with safe and efficient operations. Operations shall be arranged such that, should an incident occur, it will cause the least possible injury to personnel and damage to facilities or surrounding property.

5.2.3 Personnel Limits

5.2.3.1 Only Mission Essential Personnel shall be permitted on launch pads, in explosives handling areas, or other hazardous areas. These areas include locations where hazardous material (hazardous chemicals, rocket motors, hazardous pressure systems, etc.) are present.

5.2.3.1.1 Hazardous Operations - For hazardous operations, the OSS shall assure that the number of personnel performing hazardous tasks is kept to a minimum (no less than 2).

5.2.3.1.2 Non-Hazardous Operations – For operations around hazardous materials, the number of personnel shall be maintained by those individuals involved in the non-hazardous operation.

5.2.3.2 For off-range operations, WFF employees (NASA and/or contractor) shall abide by the requirements of the launch range conducting the operation(s) if that range has requirements or limits more stringent than WFF.

5.2.3.3 Requirements regarding official visitors or guests, tours, etc. are as follows:

5.2.3.3.1 Early notification of an impending visit or tour shall be given to the OSS responsible for the operations prior to the individual or group arrival. Potentially hazardous operations or tasks shall be brought to a safe stopping place (Category B state) and all work on hazardous systems will cease while the tour is in progress.

5.2.3.3.2 If the hazardous system cannot be placed in a Category B status (e.g., pad arming has already occurred), and it has been determined by the Chief, Range and Mission Management Office (or his designee) that the visit is necessary, the OSS and the RSO shall determine the most convenient time and duration for the visit.

5.2.3.3.3 For operations at other ranges (mobile or permanent), the WFF lead manager (Campaign Manager, Program Manager, or Project Manager), in conjunction with the local safety official(s) shall determine the necessity of the visit or tour and will determine the most convenient time, consistent with safety policies/requirements for the visit to occur

5.2.3.3.4 Tour groups will be accompanied by a person of authority such as the OSS and will consist of no more than twelve (12) people. The twelve (12) people will include the Tour Guide (Supervisor, Campaign Manager, Mission Manager, Project Manager, or their designee). If the group is larger than twelve (12), it will be split into as many smaller groups as are necessary to maintain the limit. The Chief of the Safety Office may approve larger groups upon request from the Program/Project Manager.

5.2.3.3.5 Members of the tour group shall not be permitted to touch or handle any ordnance or other hazardous hardware. No RF emitting devices (i.e. cell phones, pagers, handheld two-way radios, etc.) shall be allowed without OSS approval.

5.2.3.3.6 All area-specific safety requirements shall be enforced (i.e., safety glasses, hard hats, grounding, clothing, etc.). The person of authority shall determine the necessity of wearing static dissipative garments when in the vicinity of explosives or other static sensitive materials.

5.2.4 Ground Safety Plan

5.2.4.1 A Ground Safety Plan will be prepared by the Ground Safety Group (GSG) prior to any potentially hazardous operation or launch conducted at or managed by WFF. This plan will identify the potential hazards and describe the system designs and methods employed to control the hazards. This plan shall also establish controls to protect high value property, as required.

5.2.4.2 For launch or other potentially hazardous ground operations conducted at other ranges, this information shall be provided in a Ground Safety Plan or Ground Safety Data Package.

5.2.4.3 Where applicable, a general Ground Safety Plan may be prepared for repetitive operations/ programs which shall identify safety planning for all potential hazards. This plan may be augmented for mission operations by a mission specific Ground Safety Plan.

5.2.5 Hazard Categories

Hazard categories are established to differentiate between hazardous and non-hazardous systems. Each system is analyzed and categorized as either Category A, Category B, or Category A/B. All hazardous systems shall be considered Category A until Category B conditions have been determined and approved.

5.2.5.1 Category A systems are those systems which meet all the following: (1) initiation of the system could lead to a chain of events which result in injury or death to personnel or damage to property; (2) sufficient potential energy exists to initiate the device; and (3) the energy output of the system is not controlled by approved mechanical restraints or other safety devices.

5.2.5.2 Category B systems are those systems which (1) are highly improbable of being initiated, or (2) shall not cause injury to personnel or damage to property by either the expenditure of their own energy or the chain of events they initiate.

5.2.5.3 Category A/B systems are those systems which change from Category B to Category A during the various stages of processing. The change in hazard category is accomplished by utilizing approved out-of-line SAFE/ARM devices, mechanical restraining devices, employing the man-rated design requirements defined in Section 5.3.4.4.5, Man-Rated Circuit Design Requirements, or Section 5.3.11, Man-Rated Liquid Propulsion Systems, or by other approved means which reduce the effects of an inadvertent actuation to a nonhazardous condition or reduces the probability of occurrence to acceptable levels. The Category A or Category B requirements shall apply as appropriate.

5.2.5.4 The classification of each system, the devices or means of reducing the classification level, the danger area, restrictions, and list of responsible persons shall be identified in the Ground Safety Plan or Ground Safety Data Package for each program.

5.2.6 Multiple Operations

Multiple unrelated operations shall not be conducted simultaneously within a single operational danger area unless the operations are reviewed and specifically approved by the WFF RSO or his designee.

5.3 **Specific Policies and Criteria**

5.3.1 Hazard Categorization

5.3.1.1 All hazardous systems, including electrical, chemical, pressure etc., shall be categorized into either hazard category A, B, or A/B.

5.3.1.2 Hazardous systems shall be assumed Category A until conditions have been met which shall permit a change to Category B. Category A systems can be categorized Category A/B when any of the following conditions exist:

5.3.1.2.1 Approved restraining devices are employed to reduce the effects of an inadvertent actuation to a nonhazardous condition.

5.3.1.2.2 The hazardous system is installed but not connected to its controlling electrical circuit. Hazardous ordnance systems shall also have their Electroexplosive Devices (EED's) shorted, grounded, and shielded.

5.3.1.2.3 Ordnance systems employ an approved mechanical or electromechanical SAFE/ARM device, which provides an out-of-line feature in the SAFE position.

5.3.1.2.4 Systems employ the man-rated circuit design requirements established in Section 5.3.4.4.5, Man-Rated Circuit Design Requirements.

5.3.1.2.5 For hazardous chemical systems, the system is closed, contains two independent verifiable safeties in the flow path, and leak integrity is verified.

5.3.1.2.6 For pressure systems, the pressure is steady-state and less than or equal to the Maximum Allowable Working Pressure (MAWP).

5.3.1.3 For Category A/B systems, the change from Category B to a Category A shall be performed as late as possible in the processing sequence.

5.3.2 Danger Areas

For all hazardous systems, a danger area shall be defined which will adequately contain the hazard and protect personnel should an inadvertent actuation occur. Restrictions shall be established to prohibit access into the danger area when the possibility of initiating the hazardous system exists.

5.3.2.1 Prelaunch and Launch Danger Areas shall be defined in the Ground Safety Plan/Data Package for each mission.

5.3.2.2 Mission-specific danger areas for chemical, pressure, radiation, or other hazardous subsystems shall be defined on a case-by-case basis and shall be identified in the Ground Safety Plan/Data Package for that mission.

5.3.2.3 Flight control danger areas and their implementation shall be defined in the Ground Safety Plan/Ground Safety Data Package when applicable.

5.3.3 Operations/Design Considerations

5.3.3.1 This document allows range users to utilize various acceptable design techniques defined in Section 5.3.4, Hazardous Circuit Design Requirements. Prelaunch operational requirements should be a factor in selecting a specific design because operations that require personnel to be located inside danger areas during power switching, power on, and RF transmissions can only be performed if:

(1) The system is in a Category B condition, or
(2) The man-rated design defined by Section 5.3.4.4.5, Man-Rated Circuit Design, is employed.

5.3.3.2 Category A systems may be converted to a Category B state by implementing any of the requirements cited in paragraph Section 5.2.5.3.

5.3.3.3 All Category A danger areas shall be cleared of personnel for operations that require power switching, power ON, or RF transmissions, except as identified in Section 5.3.3.8.

5.3.3.4 Personnel may be allowed in the danger area of a Category A system whenever there are no power switching, power ON, or RF transmissions occurring and two independent inhibits are verified in place.

5.3.3.5 No personnel shall be allowed within the danger area of a Category A system if the system has been reduced to only one inhibit.

5.3.3.6 Prior to switching Ground Support Equipment (i.e., vacuum systems, heaters, etc.) ON for the first time, the applicable danger area will be cleared of all personnel regardless of the system status.

5.3.3.7 Prior to making an electrical change on a Category B system, all personnel in the vicinity shall be notified of the impending event.

5.3.3.8 Personnel may be allowed in danger areas to perform work external to the vehicle when power is supplied to a Category A system and no power switching is occurring. This operation shall be specifically approved by the WFF RSO or his designee and can only occur after power has been cycled several (not less than 3) times and has remained ON in a steady state condition for a reasonable (minimum 5 minutes) amount of time.

5.3.4 Hazardous Circuit Design Requirements

5.3.4.1 All circuits that initiate ordnance devices or initiate other hazardous systems shall be approved by the GSG prior to granting approval for use at WFF.

5.3.4.2 Category B System Requirements

Category B systems shall contain a minimum of two independent safety devices which prevent an inadvertent actuation.

5.3.4.3 Category A/B system requirements

5.3.4.3.1 The electrical circuit shall contain a minimum of two independent open contacts between the power source and the system initiator.

5.3.4.3.2 The system shall be designed such that the conversion from Category B to Category A shall minimize personnel exposure to the hazard. The final conversion to Category A shall occur during arming operations.

5.3.4.3.3 Mechanical restraint designs shall be approved by the Chief, Safety Office or his/her designee.

5.3.4.4 Category A System Requirements

5.3.4.4.1 All circuits initiating Category A devices or systems shall satisfy the circuit design criteria identified below.

5.3.4.4.1.1 All EED's shall meet a 1 amp/1 watt NO FIRE requirement and be 100% qualified with a 500 VDC megohmmeter test for 5 seconds from bridgewire to case confirming a minimum resistance of 2 MOhm.

5.3.4.4.1.2 Electrical wiring and power source shall be completely independent and isolated from all other systems; they shall not share common cables, terminals, power sources, tie points, or connectors with any other system.

5.3.4.4.1.3 All circuit wiring shall be twisted and shielded and independent of all other systems. When not physically possible to maintain the shield throughout the entire electrical circuit, as a minimum

the wiring shall be twisted and shielded from the system initiator to the point of the first short circuit condition. This requirement is applicable both before and after installation of SAFE/ARM type connectors. The use of single wire firing lines, with the shield as the return, is prohibited.

5.3.4.4.1.4 Shielding shall provide a minimum of 20 dB safety margin below the minimum rated function current of the system initiator (max NO-FIRE current for EED's) and provide a minimum of 85% optical coverage. (A solid shield rather than a mesh would provide 100% optical coverage.)

5.3.4.4.1.5 Shielding shall be continuous and terminated to the shell of connectors and/or components. The shield shall be electrically joined to the shell of the connector/component around the full 360 degrees of the shield. The shell of connectors/components shall provide attenuation at least equal to that of the shield.

5.3.4.4.1.6 The electrical circuit to which the system EED is connected shall be isolated from vehicle ground by no less than 10K ohms.

5.3.4.4.1.7 All circuits shall be designed with a minimum of two independent safety devices. Any time personnel are exposed to a hazardous system; a minimum of two independent safety devices is required to be in place.

5.3.4.4.1.8 The system EED shall be provided with an electrical short until its programmed actuation. This requirement does not negate the use of solid-state switches.

5.3.4.4.1.9 Any electrical relay or switch, which is electrically adjacent to the system initiator (either in the power or return leg of the electrical circuit), shall not have voltage applied to the switching coil (or the enable/disable circuit for solid state relays/switches) until the programmed initiation event.

5.3.4.4.2 Charged ("Hot") batteries may be installed into Category A circuits only if at least one of the following design approaches is utilized. Otherwise, the battery shall be charged at the latest feasible point in the countdown process with no personnel in the defined danger area.

5.3.4.4.2.1 The system is designed with a mechanical or electromechanical SAFE/ARM device, which shall adequately contain the output of the system or its initiator when in the SAFE position.

5.3.4.4.2.2 The system is designed to meet Capacitive Discharge Ignition (CDI) circuit criteria as defined in Section 5.3.4.4.4, CDI Circuit Design Requirements.

5.3.4.4.2.3 The system is designed to meet man-rated circuit requirements as defined in 5.3.4.4.5, Man-Rated Circuit Design Requirements.

5.3.4.4.2.4 The system is designed to meet Exploding Bridgewire (EBW) circuit requirements as defined in Section 5.3.4.4.6, Exploding Bridgewire Circuit Design Requirements.

5.3.4.4.3 Category A circuits shall be designed such that the following operations can be accomplished:

5.3.4.4.3.1 Mechanical installation and electrical connection of the system initiators can be performed at the latest possible time in the assembly process, consistent with other assembly operations.

5.3.4.4.3.2 Prior to connecting an EED to its electrical circuit, it shall be shorted, shielded, and grounded. Connect EED’s to chassis ground and the chassis to a single-point earth ground.

5.3.4.4.3.3 Prior to connecting system initiators to their electrical circuit, voltage checks shall be made between each leg of the circuit and from each leg to ground to ensure no voltage is present.

5.3.4.4.4 <u>CDI Circuit Design Requirements</u>

CDI circuit shall meet the requirements in Sections 5.3.4.4 through 5.3.4.4.3.3 and the following additional requirements.

5.3.4.4.4.1 The charging battery shall be current limited such that it shall not exceed 10% of the minimum rated function current of the system initiator (max NO-FIRE current for EED's).

5.3.4.4.4.2 The firing capacitor shall be provided with an electrical short (when the circuit is in the SAFE condition) and a means of remotely monitoring capacitor voltage. Whenever personnel are exposed to the system, the firing capacitor shall be shorted.

5.3.4.4.4.3 There shall be a minimum of two independent open switches between the power source and the system initiator.

5.3.4.4.5 Man-Rated Circuit Design Requirements

Man-rated circuit shall meet the requirements in paragraph in Sections 5.3.4.4 through 5.3.4.4.3.3 and the following additional requirements.

5.3.4.4.5.1 The system initiator shall be both physically and electrically isolated from the power source by a minimum of three independent safety devices. This requirement is applicable both before and after installation of SAFE/ARM type connectors. Electromechanical out-of-line SAFE/ARM devices that can be both Armed and Disarmed remotely shall be counted as two safety devices.

5.3.4.4.5.2 The system initiator shall be electrically isolated by switches in both the power and return legs. The wiring between the initiator and the switch in both the power and return legs shall have the following additional features:

5.3.4.4.5.2.1 The wiring shall be in a separate cable, which is twisted, shielded, double insulated, and independent of all other systems. Shielded wiring shall meet the requirements of 5.3.4.4.1.4 and 5.3.4.4.1.5.

5.3.4.4.5.2.2 Protection by use of physical barriers or by physical location of components shall be employed such that short circuits to other power systems are impossible, even assuming loose or broken wires.

5.3.4.4.5.3 A Failure Mode and Effects Analysis (FMEA) shall be performed to ensure a minimum of three independent failures are required for a premature actuation to occur. The detail level of the FMEA shall be established by the WFF RSO and shall be based on factors such as type of system, system design, and level of hazard.

5.3.4.4.5.4 A Quality Assurance Program shall verify compliance with all requirements and certify the "as built" configuration.

5.3.4.4.6 Exploding Bridgewire (EBW) Circuit Design Requirements

5.3.4.4.6.1 A means of continuously monitoring the firing capacitor voltage shall be provided.

5.3.4.4.6.2 Two separate electrical paths to discharge the firing capacitor shall be provided. This can be provided either through the EBW circuit or through the Ground Support Equipment (GSE).

5.3.4.4.6.3 A positive means of interrupting the capacitor charging circuit shall be provided.

5.3.4.4.6.4 A positive means of interrupting the EBW triggering circuit shall be provided.

5.3.4.4.6.5 A time delay of several seconds between application of the arming signal and application of the trigger signal for the EBW to fire shall be provided.

5.3.5 Ground Support Equipment (GSE)

5.3.5.1 The design of GSE used to make measurements on or provide control of hazardous devices, systems, or circuits shall be approved by the Chief, Safety Office or his/her designee.

5.3.5.2 All electrical meters or test equipment used to make measurements of hazardous systems shall be current limited to the manufacturer's recommendation for that device. This value shall not exceed 50 mA**.**

5.3.5.3 All GSE used in, or to obtain measurements of, hazardous systems (electrical meters, pressure gages, slings, scales, etc.) shall be calibrated/certified and may not be used beyond the certification period. Certifications shall be performed at GSFC's WFF unless approval for certifications performed at other sites/facilities is obtained from the Chief, Safety Office.

5.3.5.4 All meters that are used to measure resistance of ordnance devices are required to be tested for proper operation immediately prior to starting a hazardous procedure.

5.3.5.5 All lifting devices, fixtures, and equipment shall conform to the standards and regulations of NASA STD 8719.9, Standard for Lifting Devices and Equipment and GPR 8719.1, Certification and Recertification of Lifting Devices & Equipment.

5.3.5.6 Electrically operated GSE (vacuum systems, heaters, pumps, etc.) used on Category A systems shall meet the following design criteria and restrictions.

5.3.5.6.1 All GSE shall be designed such that the system can be remotely switched ON/OFF.

5.3.5.6.2 No personnel shall be permitted to be within Danger Areas defined in safety plans while power is being supplied to its GSE.

5.3.5.6.3 GSE shall be switched OFF prior to system arming operations. After arming operations are complete, the GSE may be switched ON provided Section 5.3.5.6.1 and Section 5.3.5.6.2 are satisfied.

5.3.5.6.4 The design of GSE should consider the impact of the above restrictions on operations. Flyaway connectors should be used to permit system operation late in the countdown process. For vacuum systems, a remotely operated valve is recommended to maintain vacuum integrity when power is switched OFF.

5.3.6 Electrostatic Discharge (ESD) Hazards

5.3.6.1 Precautions shall be taken to eliminate or reduce the risk of electrostatic discharge during potentially hazardous operations. The method used to eliminate or reduce static electricity is to provide an electrically continuous path to ground. All conductive objects (including personnel) shall be electrically connected to a common ground.

5.3.6.2 Grounding straps shall be used to bridge locations where electrical continuity may be broken by grease, paint, or rust. Equipment in contact with conductive floors or tabletops is not considered adequately grounded.

5.3.6.3 Wire used as a static ground conductor shall be large enough to withstand mechanical damage and shall not be less than American Wire Gauge (AWG) No. 8 or a braided cable of equal conductivity.

5.3.6.4 Connection of static ground conductor shall be made to certified grounding points. Grounding point certification shall be performed annually.

5.3.6.5 When performing potentially hazardous operations on electrostatic sensitive systems, personnel shall comply with the following:

5.3.6.5.1 Wrist straps shall be worn and connected to a certified ground when handling EED's or when working on exposed rocket motor grain. Wrist straps shall be tested prior to use.

5.3.6.5.2 Outer garments (e.g. lab coats or overalls) that dissipate static charges shall be worn. Under special circumstances, the WFF RSO, or his designee may waive the use of static dissipative outer garments.

5.3.6.5.3 Personnel are required to touch the ground system upon entering an ordnance work area. This grounding requirement applies even when wearing protective clothing.

5.3.6.5.4 Ionization - Ionizers may be used for static neutralization in ordnance work areas, only with specific approval from the Chief, Safety Office. Use of these instruments shall be allowed only when other means of static neutralization are not effective and may never be used directly on ordnance items.

5.3.7 Electrical Storm Criteria

5.3.7.1 When an electrical storm is detected within 15 nautical miles or the potential for an electrical storm is forecast within 10 nautical miles of potentially hazardous work areas, a warning shall be issued to bring operations to an appropriate stopping point.

5.3.7.2 When the storm is detected within 10 nautical miles or the potential for an electrical storm is forecast within 5 nautical miles of potentially hazardous work areas, the area shall be evacuated regardless of the status of the operations.

5.3.7.3 If a warning system is not available to determine the approach of an electrical storm; the potentially hazardous work area shall be cleared upon hearing thunder or observing weather conditions, which have the potential of producing electrical storms.

5.3.8 Radiation Systems

Radiation shall be adequately controlled during all operational phases to assure the protection of personnel, facilities and equipment and compliance with applicable federal, state, and NASA regulations. Such sources include radio-frequency/microwave emitters, radioactive materials, X-ray devices, lasers, and optical emitters. Radiation hazards shall be jointly defined with the GSFC Radiation Safety Committee.

5.3.8.1 Non-ionizing Radio Frequency (RF) Radiation Controls

5.3.8.1.1 The RF-radiation sources used at WFF shall be approved by the Wallops Frequency Utilization Management Working Group.

5.3.8.1.2 All operations involving the use of RF transmitters shall be coordinated through the Range Control Center (5.4.2.2) and conform to the standards and regulations specified in IEEE C9S.1-1991 and GPR 1860.3, Radio Frequency Radiation Safety.

5.3.8.1.3 The use of Flight Termination System (FTS) frequencies shall be coordinated with the WFF Frequency Utilization Group. Open air transmitting of ARM and DESTRUCT tones is prohibited unless scheduled.

5.3.8.1.4 Mission-specific descriptions of RF transmitters and restrictions shall be provided in the Ground Safety Plans/Data Packages.

5.3.8.1.5 RF radiation into areas where ordnance operations are conducted shall be controlled to assure insufficient energy exists to cause premature initiation of ordnance.

5.3.8.1.6 The RF avoidance times shall be established in operational plans for all transmitters capable of producing a potential hazard to any ordnance operation. The RF avoidance is defined as no radiation within ±20 degrees (azimuth and elevation) of the ordnance site. The WFF RSO or designee shall approve any deviation of this requirement.

5.3.8.1.7 Personnel and ordnance hazard distances for all transmitters shall be jointly defined with the GSFC Radiation Safety Committee.

5.3.8.2 Ionizing Radiation Controls

5.3.8.2.1 All operations involving the use of radioactive sources shall conform to the standards and regulations of the Nuclear Regulatory Commission, GPR 1860.1, Ionizing Radiation Protection and regulations of the host range.

5.3.8.2.2 The range user is responsible for obtaining all licenses for radioactive materials.

5.3.8.2.3 Procedures for the use, handling, and storage of radioactive sources shall be designed to minimize the exposure of personnel. All ionizing radiation producing materials and equipment will be inspected and monitored upon arrival and prior to shipment to any other location.

5.3.8.2.4 Range users shall identify all radioactive sources and provide Material Safety Data Sheets (MSDS) for each radioactive source to be used. This includes calibration sources as well as test sources.

5.3.8.2.5 Range users shall provide WFF with detailed operating procedures for use, handling, and storage of non-exempt radioactive sources as defined in Title 10 - Code of Federal Regulations - Parts 19 and 20 while on the range. Specific data requirements are listed in Section 8.0, WFF Safety Data Requirements, and GPR 1860.3, Radio Frequency Radiation Safety.

5.3.8.2.6 Ionizing radiation sources shall be removed from the range by the range user at the end of the program.

5.3.8.3 Laser Hazards Control

5.3.8.3.1 All operations involving the use of lasers shall comply with the standards and regulations of ANSI Z136.1, Safety Use of Lasers, and GPR 1860.3. Lasers entering the National airspace will have a Federal Aviation Administration (FAA) letter of non-objection.

5.3.8.3.2 Access and laser illumination levels shall be controlled to insure that no personnel are present within the ocular and skin hazard areas of the laser unless suitable protection is provided.

5.3.8.3.3 Range users shall provide WFF with characteristics and detailed operating procedures for controlling and use of lasers. Completing the GSFC Forms 23-28L, 23-6L, and 23-35 LU will do this. All Class 3 and 4 laser operations shall be approved by the Laser Safety Officer.

5.3.8.3.4 Lasers with potential to strike orbiting satellites will obtain a ‘site window’ from the Laser Safety Clearing House referenced in NPR 8715.3, Section 6.16.1.3.

5.3.9 Chemical Hazards

A chemical hazard is posed by any material (solid, liquid, or gas) that presents a health risk or physical hazard to personnel, property, or the environment.

5.3.9.1 Procedures addressing use, clean up, and spill response of hazardous materials shall be developed. These procedures shall be reviewed and approved by the GSG and WFF Environmental Office.

5.3.9.2.1 The WFF Environmental Offices shall be notified of hazardous materials requiring disposal.

5.3.9.3 The MSDS shall be available during all operations involving hazardous materials. Hazardous material handlers, cognizant GSG personnel, and WFF Environmental Office and Emergency Responder personnel shall have knowledge of material compatibilities, physical and health hazards, and first aid techniques relevant to the hazardous materials in question.

5.3.9.4 The following measures shall be employed if a possibility of a hazardous chemical spill exists:

5.3.9.4.1 Spill potentials shall be evaluated on a case-by-case basis, and potential hazard areas shall be defined in a Ground Safety Plan.

5.3.9.4.2 A means to minimize the surface area of potential spills by diking, design, or other methods shall be employed.

5.3.9.5 The following measures shall be used to address potential leaks of hazardous fluids or gases:

5.3.9.5.1 All GSE electrical hardware used in areas where flammable/combustible chemicals may be present in local vapor concentrations greater than 25% of the Lower Explosive Limit (LEL) shall be rated "explosion proof" in accordance with 1999 Electrical Code, Article 500 – Hazardous Locations, purged and pressurized, intrinsically safe or, if this is not possible, (1) the flammable/combustible chemical concentrations shall be continuously monitored and (2) a master switch capable of deactivating "non-explosion proof" electrical hardware shall be conveniently located in the work area. NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas provides guidance on determining the proper classification of the location.

5.3.9.5.2 Areas of hazardous fluid or gas transfer and storage shall be monitored by approved equipment to detect toxic and flammable concentrations.

5.3.9.5.3 Chemical transfer operations, which are hazardous, shall not occur without prior approval of and supervision by the OSS.

5.3.10 Hazardous Chemical System Hardware

Hazardous chemical hardware shall be designed to prevent hazardous chemicals from spilling or leaking and, thereby, injuring personnel, property, or contaminating the environment.

5.3.10.1 Hazardous chemical systems that release caustic, toxic, or reactive chemicals shall be designed such that the flow path contains two independent safeties to prevent an inadvertent release.

5.3.10.2.1 Components of hazardous chemical systems shall feature redundant mechanical or welded seals at all fittings to prevent the inadvertent flow or release of caustic, toxic, and/or reactive chemicals.

5.3.10.3 Materials selected for use in hazardous chemical systems shall be compatible with the hazardous chemical used. This should include compatibility under operating pressure, shock, vibration, reactivity and temperature conditions. Analyses on items such as stress corrosion or adiabatic compressibility shall be performed when applicable. Specific properties of propellants may be determined by reference to standard industry manuals such as the CPIA Publication 394, Hazards of Chemical Rockets and. Propellants.

5.3.10.4 Bi-propellant systems that incorporate both a fuel and an oxidizer shall be designed such that a malfunction of either the oxidizer or fuel subsystems cannot result in mixing. In general, all hazardous chemical systems shall be designed to preclude the inadvertent mixing of hazardous chemicals, especially in cases where chemical reactions could have catastrophic consequences.

5.3.10.5 Monopropellant systems that feature a fuel and a catalytic bed shall incorporate at least two independent safeties in the flow path to prevent inadvertent fuel contact with the catalytic bed.

5.3.10.6 The need for remote status monitoring of the system and/or its components shall be evaluated by the GSG on a case-by-case basis.

5.3.10.7 Hardware (tanks, transfer lines, etc.) shall conform to applicable American Society of Mechanical Engineers (ASME) and Department of Transportation (DoT) specifications.

5.3.11 Man-Rated Liquid Propulsion Systems

5.3.11.1 General Requirements

5.3.11.1.1 A man-rated propulsion system shall be employed when the following two conditions exist: (1) a leak or spill of the propellant poses a catastrophic hazard and (2) the propulsion system is placed in a condition whereby spill response is not possible.

5.3.11.1.2 The propulsion system's primary leak path (i.e., from the propellant tank through the thrusters) shall contain a minimum of three mechanically independent safeties in series. If the mechanical safeties are electrically controlled, the electrical controls shall be independent of each other. A pyrotechnically actuated isolation valve with two fault tolerant electrical safeties immediately downstream from the liquid propellant tank shall be considered equivalent to two flow control safeties.

5.3.11.1.3 Secondary leak paths (i.e., through or around wetted fittings to the ambient environment) shall contain a minimum of two safeties in series to prevent a catastrophic leak/spill past a wetted fitting. A fitting that has been sealed by welding shall be considered equivalent to two mechanical seals. Metal-to-metal fittings (e.g., Swagelok and AN fittings) shall be considered equivalent to two safeties.

5.3.11.1.4 Prior to a launch, flow control devices within the liquid propulsion system shall not be operated under condition(s) that preclude spill/leak response.

5.3.11.2 Electrical Hardware

5.3.11.2.1 The electrical circuit(s) that operate the liquid propellant flow control devices shall be man-rated (i.e., two fault tolerant). At least two of the three electrical inhibits shall be remotely monitored when conditions preclude spill/leak response.

5.3.11.2.2 Electrical circuit(s) that operate components whose failure may cause the liquid propellant to catastrophically overheat (thus causing either propellant decomposition or propellant tank over pressurization) shall be man-rated.

5.3.11.3 Pressure Relief

5.3.11.3.1 The pressurant side of hazardous liquid propulsion systems shall be either electrically and mechanically single fault tolerant to exceed system Maximum Expected Operating Pressure (MEOP), or shall be equipped with a pressure relief device. The relief device shall be set and certified by tagging at 10% above system MEOP.

5.3.11.3.2 The system shall be mechanically and electrically two fault tolerant to exceeding system burst pressure.

5.3.11.4 Seals

5.3.11.4.1 A quality control program shall verify that all system fittings and seals are properly installed and have leak integrity.

5.3.11.4.1.1 Welds shall be made only by certified welders.

5.3.11.4.1.2 Lot and batch short-term compatibility testing shall be performed for elastomeric seals to assure material compatibility.

5.3.11.4.1.3 Positive means such as periodic leak checking, manufacturer's gaging techniques, and/or other measures shall assure that metal-to-metal seals (e.g., Swagelok and AN fittings) do not lose leak integrity by improper installation or loosening ("backing-off") during transport or handling.

5.3.11.4.2 The optimum design for redundant mechanical seals is to seat one at the fitting face and the other radially to seal the fitting.

5.3.11.5 Monitoring

5.3.11.5.1 An instrument that continuously monitors for airborne concentrations of the toxic liquid propellant shall be used during ground operations.

5.3.11.5.2 During those operations that cannot be considered ground operations but still place personnel under the jurisdiction of WFF at risk (e.g., captive flight), and when spill/leak response is not possible, system pressure monitoring shall be required as a minimum effort.

5.3.11.5.3 All personnel who work in the proximity of the fueled liquid propulsion system shall wear passive dosimeters to monitor possible personnel exposures.

5.3.12 Pressure Systems

5.3.12.1 All ground support pressure systems shall meet NPD 8710.5.

5.3.12.2 Unrestricted access shall be granted for all airborne pressure systems (gaseous and liquid) that are designed in accordance with recognized DoT and ASME standards or have stored energy levels less than 19,130 Joules (14,240 ft-lbs) and operating pressure less than 100 psi. Systems that contain fluids that are toxic and/or flammable shall also meet requirements of Sections 5.3.9, 5.3.10, or 5.3.11 as applicable.

5.3.12.3 If the airborne pressure system does not meet Section 5.3.12.2, then it shall be remotely pressurized for any of the following:

5.3.12.3.1 During the initial pressurization of the system, following system assembly or refurbishment. Initial pressurization shall certify system integrity up to 25% of Design Burst Pressure.

5.3.12.3.2 After the pressure system has been exposed to excessive vibration or shock or it has been transported in an unknown environment.

5.3.12.3.3 During pressurization above 25% of the Design Burst Pressure.

5.3.12.4 All airborne systems used on NASA orbital and NASA sub-orbital launch vehicles shall comply with the design requirements of ANSI/AIAA S-080 or ANSI/AIAA S-081.

5.3.12.5 Restricted access is permitted for airborne pressure systems designed to the requirements of ANSI/AIAA S-080 or ANSI/AIAA S-081.

5.3.12.5.1 Restricted access shall be permitted when the system steady state pressure is less than the MEOP.

5.3.12.6 Whenever the system pressure exceeds the MEOP, personnel shall be separated from the pressure vessel(s) by a barrier designed to protect against blast and fragmentation, or personnel shall be outside the pressure vessel danger area

5.3.12.6.1 The pressure vessel danger area shall be defined in the Ground Safety Plan/Data Package for that mission.

5.3.12.7 Flight pressure systems shall be re-certified by inspection, testing, or analysis prior to being reflown. The method of recertification shall be documented in an approved plan for each pressure vessel.

5.3.12.8 If a pressure relief device is employed; it shall be set and certified by tagging at no greater than 10% above MEOP. This pressure level is defined as the Maximum Design Operating Pressure (MDOP), and may not exceed the proof pressure.

5.3.13 Personal Protective Equipment (PPE)

Safety glasses, safety shoes, hard hats, arctic clothing, shop coats, etc., are required to be used by GSFC's WFF employees, contractors, experimenters, and range users when exposed to certain hazardous conditions. Employees will be trained on the proper use and care of personal protective equipment. Appropriate medical examinations may be required. Prior to international travel, physical examinations are required in accordance with GPR 1800.4, Occupational Medicine and Employee Assistance Program.

5.3.13.1 All personnel shall wear static-dissipating clothing in processing areas for ordnance or other hazardous systems, which are susceptible to electrostatic discharge. Ordnance handlers shall not wear static producing clothing (i.e., wool, rayon, nylon, polyester, etc.).

5.3.13.2 During operations involving EED or exposed grain, all personnel are required to wear approved, grounded wrist-straps. Approved leg-stats may be used in place of wrist-straps for specific operations approved by the Chief, Safety Office.

5.3.13.3 Safety glasses or face shields are required for operations where an ocular hazard may exist.

5.3.13.4 Hardhats are required for operations where personnel work on multiple levels or where overhead objects may impact the employee (i.e. crane and lifting operations).

5.3.13.5 Operations involving chemicals that pose a health risk require that personnel wear protective equipment (identified on a case-by-case basis in the specific operational procedure) that shall provide respiratory and/or full body protection during:

5.3.13.5.1 Connecting or disconnecting wet lines or contaminated (neither purged nor flushed) dry lines.

5.3.13.5.2 Sampling operations.

5.3.13.5.3 Flow/transfer operations.

5.3.13.5.4 Operations where there is only one safety device preventing a chemical spill.

5.3.13.5.5 Chemical spill cleanup.

5.3.13.6 Personnel working with cryogenic liquids shall wear proper protective equipment including: hand and foot protection, face protection, and appropriate outer garments

5.4 **Operational Security, Controls, and Procedures**

The WFF has established operational safety controls with which all persons at WFF shall comply. These controls include:

5.4.1 Security

5.4.1.1 There are four classes of badges signifying the wearer's authorization to be in potentially hazardous areas. These badges are applicable to the entire facility (Wallops Island, Wallops Mainland, and WFF Main Base) and all off range sites under the auspices of Code 800. These classes and their definitions are as follows:

5.4.1.1.1 ALL-HAZ
All hazards – wearer is authorized unescorted access to all potentially hazardous areas. However, OSS approval is required prior to the wearer entering an area where a hazardous operation is occurring. ALL-HAZ badges are reserved for personnel associated with facility infrastructure.

5.4.1.1.2 SPEC-HAZ
Mission specific hazards – wearer is permitted same level of access as ALL-HAZ except that the wearer must be specifically associated with the hazardous system/area.

NOTE: The Chief of the Safety Office must approve all ALL-HAZ and SPEC-HAZ badges.

5.4.1.1.3 NON-HAZ
No hazards – Default badge class - wearer is only allowed in areas where no hazardous programmatic systems exist.

NOTE: Personnel possessing a NON-HAZ badge can gain access to hazardous areas provided their presence is required in the area and they are escorted by someone wearing an ALL-HAZ or a SPEC-HAZ badge.

5.4.1.1.4 NONE
No NASA areas - Issued to Navy personnel granting them access to the Navy facilities on Wallops Island.

5.4.1.2 Danger Area Access - Access into operational danger areas at WFF is controlled by the Danger Area Warning System and roadblocks. Admittance into the danger area is always controlled by the OSS.

5.4.1.2.1 Danger Area Warning System - WFF Danger Area warning systems involve the use of lights, sirens, signs, and/or roadblocks to alert personnel of the potential hazards present in certain areas and/or to prevent personnel from entering these areas. Under no circumstances shall personnel pass through an active danger area warning system without first obtaining permission from the OSS or his designee.

5.4.1.2.2 Launch Pad Warning System – WFF Launch Pad Warning Systems involve the use of lights and exterior public address systems to advise personnel during Danger Time I, Danger Time II, Caution Time, and All Clear status changes, or other hazardous periods. Hazard warning lights are visible from all angles of approach. These systems are operated to indicate the following conditions:

5.4.1.2.2.1 Danger Time II - Flashing red light at launch pad and danger area roadblocks are in place. No personnel are permitted access to the pad.

5.4.1.2.2.2 Danger Time I - Flashing amber light at pad and danger area roadblocks are in place. Only active/essential personnel performing specific tasks are permitted access to the pad, with the permission of the OSS. This condition will exist if system(s) are in a potentially hazardous condition (i.e. Category A)

5.4.1.2.2.3 Caution Time - Flashing amber light at pad and danger area roadblocks are in place. Only essential personnel with OSS's permission are permitted access to the pad. This condition will exist if system(s) are not in a potentially hazardous condition (i.e. Category B).

5.4.1.2.2.4 All Clear - No warning lights at pad or prelaunch roadblock. All personnel are permitted access to the pad.

5.4.1.2.3 Launch Pad Roadblocks - In addition to the warning systems, manned and/or unmanned roadblocks are established at various places and times. Under no circumstances shall personnel pass through a roadblock without permission from the OSS or his designee. For more information on unmanned roadblocks, refer to 800-PG-8715.1.1, Unmanned Roadblocks for Hazardous Operations.

5.4.1.3 Explosives Signs and/or Symbols - Based on procedures of the U. N. document "Transportation of Dangerous Goods" (documented in NASA STD-8719.9), the WFF utilizes four symbols to denote different classes of ordnance. These symbols are prominently displayed on International Orange signs at each magazine and refer to the most hazardous material stored within.

5.4.1.3.1 Class 1, Division 1: an octagonal-shaped sign displaying the numeral "1" in the center denotes the presence of Department of Defense (DoD) Hazard Class/Division 1.1 explosives, which present a blast and fragmentation hazard and can be expected to mass detonate when exposed to fire.

5.4.1.3.2 Class 1, Division 2: an X-shaped sign displaying the numeral "2" in the center denotes the presence of DoD Hazard Class/Division 1.2 explosives, which present a fragmentation hazard.

5.4.1.3.3 Class 1, Division 3: an inverted triangular sign displaying the numeral "3" in the center, denotes the presence of DoD Hazard Class/Division 1.3 explosives, which present a mass fire hazard.

5.4.1.3.4 Class 1, Division 4, on a diamond-shaped sign displaying the numeral "4" in the center, denotes the presence of DoD Hazard Class/Division 1.4 explosives, which present a moderate fire hazard.

5.4.1.4 RF Radiation Controls

5.4.1.4.1 Operational Restrictions - All RF emitters used at WFF shall be periodically analyzed to determine whether or not they pose a potential hazard to personnel or ordnance. When a potential hazard exists, operational restrictions and/or controls shall be established to protect personnel and/or ordnance systems.

5.4.1.4.2 Barricades/Signs - In areas where RF hazards to personnel exist, signs and/or barricades shall be erected to prevent personnel from entering the potential hazard area.

5.4.1.4.3 Warning Lights - On high power RF emitters such as Radar Systems, red and blue warning lights shall be utilized to warn personnel of the potential RF hazard. A red flashing light shall be illuminated whenever power is supplied to the system. A blue flashing light shall be illuminated whenever the emitter is radiating.

5.4.2 Operational Controls

For all potentially hazardous operations at WFF, the Test Director (TD), Range Operations Assistant (ROA), RSO, and OSS exercise control over all personnel associated with the operation. For off-range operations, Section 2.7 establishes the hierarchy for operational control.

5.4.2.1 All NASA personnel, NASA contractors, experimenters, range users, and tenants are responsible for:

5.4.2.1.1 Adhering to the requirements established in this document.

5.4.2.1.2 Adhering to the directions issued by the TD, RSO, and/or OSS.

5.4.2.1.3 Reviewing vehicle and payload operations with the OSS.

5.4.2.1.4 Obtaining permission from the OSS before conducting any operation in assembly, test, or launch areas.

5.4.2.1.5 Identifying active essential personnel for each operation to assure maximum personnel limits are not exceeded.

5.4.2.2 All RF radiation on WFF is controlled through the Wallops Frequency Utilization Management Working Group. The use of RF sources during hazardous operations is managed by the ROA. Range users shall obtain permission through the OSS before any RF transmitters can be switched ON.

5.4.2.3 The Ground Safety Plan/Data Package defines Danger Area clearance requirements and personnel restrictions for all potentially hazardous operations. All personnel at WFF are responsible for complying with these restrictions.

5.4.2.4 All personnel performing potentially hazardous operations (explosives handling, chemical transfer, etc.) shall be trained and experienced as per 800-PG 8715.0.2, Training and Certification Procedures for Ordnance Handlers at GSFC/WFF. These personnel are required to be certified or directly supervised by certified personnel when performing these operations. WFF may approve certifications established by user programs. Range user**s** shall provide documentation that supports training, experience, or certification of their personnel.

5.4.3 Operational Procedures

5.4.3.1 Range users are responsible for submitting to WFF all comprehensive handling, assembly, and/or checkout procedures for all hazardous systems for review and approval. Operations shall not be conducted until the Safety Office has approved these assembly and test procedures.

5.4.3.2 Under no circumstances shall a potentially hazardous operation begin without prior approval from the OSS.

5.4.3.3 The WFF requires that no unrelated tasks be conducted simultaneously, within overlapping Danger Areas, on hazardous systems. It is the responsibility of all supervisory personnel to prepare work schedules to comply with this requirement.

5.4.3.4 Instruments used to measure the resistance of EED's shall (a) contain a certification sticker and (b) be checked, immediately prior to use, to assure the short circuit current is less than 50mA.

5.4.3.5 Range users shall obtain permission from the OSS prior to making a power switch on any vehicle/payload or ground support system.

5.4.3.6 Emergency Procedures - Prior to conducting an operation, WFF shall establish emergency procedures and an emergency response team in the event of launch abort or recovery. Range Users shall identify personnel as required by WFF to participate on any emergency or recovery team. The termination of the emergency phase begins the mishap investigation phase. The emergency procedures will support this transition.

5.4.3.7 For off-range operations, permission to perform the above operations shall be granted by the hierarchy defined in Section 2.5.

6.0 FLIGHT SAFETY

6.1 Policies

6.1.1 The flight safety goal is to protect the public, range participants, and property from the risk created by conducting potentially hazardous operations at WFF and to prevent mishaps that would result in embarrassment to NASA or the United States Government. Although these risks can never be completely eliminated, the flight should be carefully planned to minimize the risks involved while enhancing the probability for attaining the mission objectives.

6.1.2 The WFF is responsible for flight safety until all flight components have reached impact or have achieved orbital insertion. A Flight Safety Program shall be implemented to protect the public and participating personnel for all WFF launch operations and operations conducted by WFF at mobile ranges established at remote sites. For operations conducted at other established ranges, WFF is responsible for assuring that NASA personnel, contractors, and

experimenters are not exposed to risk greater than the acceptable risks established by this document.

6.1.3 Flight safety is generally associated with the containment of vehicle flight within approved operational areas and impacts (spent stages, payloads, balloons, payload/parachutes, etc.) within planned impact areas. Since the entire set of variables (vehicle aerodynamic/ballistic capabilities; azimuth and elevation angles; wind effects, air and sea traffic, and proposed impact areas) are unique, flight safety analysis shall be performed for each mission. Vehicle design, reliability, performance, and error predictions for each flight case shall be reviewed by the Safety Office personnel to assess the flight-worthiness of the launch vehicle.

6.1.4 Flight safety data shall be prepared by the Flight Safety Group (FSG) of WFF prior to any launch operations where WFF has flight safety responsibilities. This data shall be published in a Flight Safety Plan and shall describe the proposed vehicle flight and the means to contain it safely. For operations at other established ranges, any special flight safety restrictions or requirements shall be documented in a Flight Safety Data Package for that operation. For CSBF balloon operations, any special flight safety restrictions or requirements shall be documented in a program Safety Analysis Report (SAR) or an individual mission Risk Analysis document.

6.1.5 The Range Safety Officer shall approve all Risk Analysis documents and Safety plans.

6.2 **Risk Criteria**

All mission activities shall be planned such that the risk shall not exceed acceptable risk levels as listed in Section 6.2.2. For those missions where the risk cannot be mitigated below acceptable levels, the risk shall be analyzed and variances shall be approved/disapproved according to 803-PG-8715.1.2, Range Safety Deviation & Waiver Process. In all cases, risk should be minimized as low as reasonably practical.

When responsible for flight operations occurring at sites other than WFF, the more stringent risk criteria between the two shall apply.

Risk controls for protecting populated landmasses shall be implemented by establishing Casualty Expectation and Probability of Casualty limits as defined in NPR 8715.5, Range Safety Program and risk controls for protecting ships and aircraft shall be implemented by establishing maximum hit probabilities.

Procedures and methodology for calculating risk values can be found in NPR 8715.5 and the Flight Safety/Range Safety Officer Training Manual for the NASA Goddard Space Flight Center/Wallops Flight Facility. They are consistent with those employed by other national ranges such as the Eastern and Western Ranges, and with the RCC 321-02 Common Risk Criteria for National Test Ranges: Inert Debris.

There are three types of flight hazards to be considered when applicable: debris, far-field blast overpressure and toxic material release. Each is considered separately and compared to the risk criteria. See NPR 8715.5, Sections 3.2.6, 3.2.7, and 3.2.8 for more details.

6.2.1 Negligible Risk

6.2.1.1 Probability of casualty (P_c) for individuals, applied separately for each hazard, shall be less than 1×10^{-6}.

6.2.1.2 The casualty expectation, applied separately for each hazard, shall be less than 1×10^{-6}.

6.2.1.3 The probability of hitting a ship shall be less than 1×10^{-5} for each impact area.

6.2.1.4 The probability of hitting an aircraft shall be less than 1×10^{-8} for each impacting area. The minimum aircraft hazard area shall be 2 sigma.

6.2.1.5 The probability of spent stages or other vehicle debris impacting on protected property areas shall be less than 1×10^{-3}.

6.2.2 Acceptable Public Risk

6.2.2.1 Probability of casualty (P_c) for individuals, applied separately for each hazard, shall be less than 1×10^{-6}.

6.2.2.2 The casualty expectation, applied separately for each hazard, shall be less than 30×10^{-6}.

6.2.2.3 The probability of hitting a ship shall be less than 3×10^{-5} for all impact areas.

6.2.2.4 The probability of hitting an aircraft shall be less than 1×10^{-8} for each impact area. The minimum aircraft hazard area shall be 2 sigma.

6.2.2.5 The probability of spent stages or other vehicle debris impacting on protected property areas shall be less than 1×10^{-3}.

6.2.3 Center Essential Personnel Risk

6.2.3.1 Probability of casualty (P_c) for individuals, applied separately for each hazard, shall be less than 10×10^{-6}.

6.2.3.2 The casualty expectation, applied separately for each hazard, shall be less than 300×10^{-6}.

6.2.3.3 The probability of hitting a ship shall be less than 30×10^{-5} for all impact areas.

6.2.3.4 The probability of hitting an aircraft shall be less than 10×10^{-8} for each impact area.

6.2.4 Risk Criteria Process

6.2.4.1 The vehicle program, the safety office, and the authority responsible for the range, launch site, or landing site shall coordinate to make operational decisions needed to control risk prior to initiation of flight or each phase of flight.

6.2.4.2 For an orbital Reusable Launch Vehicle (RLV) or vehicle that operates continuously for extended periods, the Safety Office may make operational decisions, including the implementation of applicable per flight risk criteria, independently for each phase of flight (e.g., launch, entry, ascent, cruise, or descent) if all three of the following are satisfied:

6.2.4.2.1 Each decision is based on a risk assessment that is conducted or validated just prior to each phase of flight.

6.2.4.2.2 The assessment or validation accounts for updated vehicle status and updated predictions of flight conditions.

6.2.4.2.3 The vehicle has sufficient controllability to allow for risk management as a prerequisite to beginning each phase of flight.

6.2.4.3 For a mission that involves the operation of more than one vehicle simultaneously, the Safety Office may make operational decisions, including the use of applicable per flight risk criteria, independently for each vehicle if each vehicle has sufficient independent controllability to allow the management of risk individually for the flight of each vehicle.

6.2.4.4 The Safety Office shall identify any property in the vicinity of the flight that requires protection from potential debris impact, identify the potential damage of concern, and mitigate the associated risk.

6.2.4.5 The Safety Office shall quantify and document any risk through the conduct of a formal risk assessment and publish the results in a Risk Analysis Report (RAR).

6.2.4.6 The Safety Office shall inform operational personnel of the hazards and safety risk associated with the conduct of any range operation.

6.2.4.7 The Safety Office shall inform on-site public/visitors of hazards and safety risk associated with viewing a range operation from NASA-controlled property.

6.3 Flight Safety Risk Assessment

6.3.1 A range safety risk assessment shall be a formal documented analysis that identifies and quantifies risk for input to the risk management process.

6.3.2 The risk assessment shall provide a best estimate of the risks and include an evaluation of uncertainty bounds or sensitivities to inputs.

6.3.3 The assessment documentation shall identify all assumptions made.

6.3.4 The risk assessment shall account for variability associated with the following:

6.3.4.1 Each source of hazard, including any associated with a payload, during flight.

6.3.4.2 Normal flight and each appropriate foreseeable failure response mode of the vehicle for each flight phase.

6.3.4.3 Each appropriate foreseeable external and internal vehicle flight environment.

6.3.4.4 Public and worker population potentially exposed to the flight.

6.3.4.5 Population growth rates in order to remain valid if a risk assessment will apply to a number of flights over a number of years.

6.3.4.6 The performance of any range safety system, control, or constraint including all associated time delays.

6.3.5 Input data used for the range safety risk assessment shall include:

6.3.5.1 Quantitative assessment of vehicle reliability unless the vehicle will operate under full containment where any associated hazard cannot reach persons and property.

6.3.5.2 Proposed trajectories (nominal, preplanned contingency, abort, and malfunction trajectories).

6.3.5.3 Description of any landing sites and/or flight paths.

6.3.5.4 Description of credible failure modes and their probability of occurrence resulting in a hazard to public safety.

6.3.5.5 Reliability of any range safety system.

6.3.5.6 All hazard controls and mitigation strategies.

6.3.5.7 Pertinent vehicle information, such as size, weight, propellant types and amounts, and any explosives, toxic materials, or radionuclides.

6.3.5.8 Other relevant data required for analysis in support of specific mission objectives, including related payload information.

6.3.6 There are typically three types of hazards considered in a range safety risk assessment. These include debris, far-field blast overpressure, and toxic material release.

6.3.6.1 A risk assessment shall account for the risk due to each hazard where applicable for each flight unless the hazard is fully contained.

6.3.6.2 Other hazards may exist based on specific mission requirements, and these hazards shall be included in the assessment on a case-by-case basis.

6.3.7 Debris Risk Assessment

6.3.7.1 A Range Safety Analysis shall assess any risk due to debris for input to the risk management process. For a launch, these requirements apply to any debris that does not achieve orbit. For an entry operation, these requirements apply to any debris that might be generated, intentionally or not, after the deorbit burn or sample return capsule release.

6.3.7.2 An assessment of risk to the public and workforce due to debris shall account for each of the following as a function of flight-time or loss-of-control-time:

6.3.7.2.1 All potential debris, generated intentionally or not, that could cause a casualty, including debris that could affect someone on the ground or on a waterborne vessel, or cause an aircraft accident.

6.3.7.2.2 All populated areas in the overflight area that could be impacted by the debris.

6.3.7.2.3 The probability of the debris impacting each populated area, which accounts for the probability of vehicle failure.

6.3.7.2.4 The effective casualty area of the impacting debris, which accounts for the cross-sectional area of the debris, average size of a person, and the effects of any overpressure due to any explosive debris (debris that would explode on or after impact).

6.3.7.2.5 The population density of each populated area. The assessment should consider any risk mitigation factors associated with each population, such as sheltering and time of day of the flight.

6.3.7.2.6 Debris variability, including size, shape, aerodynamic properties, weight, and potential to survive to impact.

6.3.7.2.7 The sources of debris variability, including breakup conditions.

6.3.7.2.8 The uncertainties in the state vector at the instant of jettison or destruct and any correlations used.

6.3.7.2.9 Any velocity imparted to the debris fragments during jettison, destruct, or breakup.

6.3.7.2.10 The influence of atmospheric variability, including winds.

6.3.7.3 A debris risk assessment for any protected property identified shall account for:

6.3.7.3.1 All potential debris (intentionally or unintentionally generated) that could cause property damage, which accounts for the specific nature of the property.

6.3.7.3.2 The cross-sectional area of the debris and the effects of any overpressure due to any explosive debris (debris that would explode on or after impact).

6.3.7.3.3 Debris variability, including size, shape, aerodynamic properties, weight, and potential to survive to impact.

6.3.7.3.4 The sources of debris variability, including breakup conditions.

6.3.7.3.5 The uncertainties in the state vector at the instant of jettison or destruct and any correlations used.

6.3.7.3.6 Any velocity imparted to the debris fragments during jettison, destruct, or breakup.

6.3.7.3.7 The influence of atmospheric variability, including winds.

6.3.7.3.8 The probability of the debris impacting the property, which accounts for the probability of vehicle failure and the location, size, and shape of the property.

6.3.7.4 A range safety analysis shall establish flight commit criteria and operational constraints, such as hazard areas and impact limit lines, needed to control any risk due to debris impacts.

6.3.7.5 A range safety analysis shall establish hazard areas needed to control risk due to debris including aircraft and ship hazard areas for notices to mariners and notices to airmen.

6.3.8 Far-Field Blast Overpressure Effects Risk Assessment

6.3.8.1 A range safety analysis shall characterize the risk to the public and the workforce due to any far-field blast overpressure from potential explosions during vehicle operations for input to the risk management process.

6.3.8.2 The analysis shall establish flight commit criteria to control risk due to potential distance focus overpressure effects.

6.3.8.3 A far-field blast overpressure analysis shall account for:

6.3.8.3.1 The potential for distance focus overpressure or overpressure enhancement given current meteorological conditions and terrain characteristics.

6.3.8.3.2 The potential for broken windows and related casualties.

6.3.8.3.3 Characteristics of the potentially affected windows, including their size, location, orientation, glazing material, and condition.

6.3.8.3.4 The hazard characteristics of the potential glass shards, such as falling from upper building stories or being propelled into or out of a shelter toward potentially occupied spaces.

6.3.8.3.5 The explosive capability of the vehicle at or after impact and at altitude and potential explosions resulting from debris impacts, including the potential for mixing of liquid propellants.

6.3.8.3.6 Characteristics of the vehicle flight and the surroundings that would affect the population's susceptibility to injury, for example, shelter types and time of day of the proposed activity.

6.3.9 Toxic Hazard Risk Assessment

6.3.9.1 In the case of a catastrophic failure of a vehicle in flight, rocket fuel and oxidizer residues (e.g., aerozine-50, nitrogen tetroxide, hydrogen chloride from solid rocket motors, and their combustion products) may be present. Under certain meteorological conditions, high concentrations of these materials may drift over populated areas at levels greater than emergency health standards permit. As a result, NASA shall protect the public and workforce from toxic hazards using either hazard containment or a risk mitigation approach.

6.3.9.2 A Range Safety Analysis shall establish flight commit criteria to control any risk due to potential toxic material release.

6.3.9.2.1 The analysis shall assess any residual risk due to potential toxic material release not fully contained or mitigated for input to the program's risk management process.

6.3.9.2.2 The analysis shall account for:

6.3.9.2.2.1 Any foreseeable toxic material release during the proposed flight or in the event of a mishap.

6.3.9.2.2.2 Any operational constraints and emergency procedures that provide protection from toxic material release.

6.3.9.2.2.3 All populations potentially exposed to any toxic material release, including all members of the public and workforce on land and on any waterborne vessels and aircraft.

6.3.9.2.2.4 Potential emissions from both nominal range operations and catastrophic events to ensure response actions are designed to prevent or mitigate possible exposures.

6.3.9.3 The American Industrial Hygiene Association – Emergency Response Planning Guidelines (ERPG) – shall be used for determining the need and requirements for emergency response action plans.

6.3.10 Containment

6.3.10.1 When controlling risk through containment, the Range Safety Analysis shall provide the basis for establishing the geographical areas from which people and any protected property shall be excluded during flight.

6.3.10.2 The analysis shall determine any operational controls needed to isolate each hazard and prevent/mitigate the risk due to the hazard.

6.3.10.3 The cognizant range safety organization, in conjunction with the program, shall establish the containment criteria for normal and malfunctioning vehicle flight.

6.3.10.4 Any residual risk due to any hazard not fully contained shall undergo the risk management process.

6.3.11 Risk Mitigation

6.3.11.1 When controlling risk through mitigation, a range safety analysis shall establish the operational constraints that negate the risk or reduce it to a level that is acceptable with appropriate management approval.

6.4 **Range Safety Systems**

6.4.1 Flight Termination System (FTS)

An FTS provides for hazard mitigation during vehicle flight and may be a major component of a vehicle program's risk management approach.

6.4.1.1 Any vehicle, stage, or payload with propulsive capability that poses elevated risk to the public shall have an FTS as needed to satisfy the range safety analysis.

6.4.1.2 Flight termination systems are required to meet design and test features as specified in the RCC Standard 319-99, Flight Termination Systems Commonality Standard, EWR 127-1, Range Safety Requirements, or a tailored set of requirements to meet specific hazard analysis requirements.

6.4.1.3 When an FTS is used for a NASA or NASA-sponsored vehicle, the vehicle program shall implement a secure FTS in accordance with NPR 2810.1, Security of Information Technology.

6.4.2 Contingency Management System (CMS)

6.4.2.1 A CMS may use a set of elements within the vehicle, including but not limited to manual control, autonomous control, and recovery capability.

6.4.2.2 A CMS shall not be considered an FTS.

6.4.2.3 Activation of a CMS shall not increase the risk to people or property.

6.4.2.4 A CMS may be considered as risk mitigation and factor into the range safety risk assessment for the range operation.

6.4.3 Requirements for rockets, missiles, drones, UAV's and other similar vehicles

6.4.3.1 A FTS is required in every stage (each motor) of a launch vehicle, unless it is shown that the maximum range of the vehicle is less than the range to all protected areas, or a risk analysis shows that all of the mission risk criteria specified in Section 6.2, Risk Criteria, are satisfied, or the vehicle is inherently safe.

6.4.3.2 An operation is considered inherently safe if the predicted flight is based solely on launch and dispersion parameters and known system errors. The Chief, Safety Office or designee, is responsible for determining if an operation is inherently safe and for approving the type and design of the FTS.

6.4.3.3 Operations are considered inherently safe if all of the following conditions are true:

6.4.3.3.1 The vehicle does not contain a guidance or control system.

6.4.3.3.2 The vehicle can be accurately wind weighted to provide for an acceptable impact location.

6.4.4 Requirements for Balloons

6.4.4.1 A FTS or CMS is required, unless the maximum weight and weight per surface area criteria of CFR 14, FAA, Part 101, Moored Balloons, Kites, Unmanned Rockets, and Unmanned Free Balloons are satisfied.

6.5 **Operational Procedures**

6.5.1 Flight Commit Criteria

6.5.1.1 The flight commit criteria for a range operation shall identify the conditions that must be met to initiate each flight or phase of flight.

6.5.1.2 The flight commit criteria shall provide for:

6.5.1.2.1 Assurance that the collision avoidance requirements of Paragraph 6.5.2.3, Collision Avoidance are satisfied for any launch or entry.

6.5.1.2.2 Surveillance of any established hazard areas requiring surveillance.

6.5.1.2.3 Verification that all range safety systems are available and operational.

6.5.1.2.4 Verification that the meteorological conditions, such as wind, lightning, and visibility, are within the limits defined by the range safety analysis.

6.5.1.3 Implementation of the flight commit criteria shall include documenting the actual conditions at the time of flight or time of each phase of flight where applicable to verify that the flight commit criteria have been met.

6.5.2 Rocket, Missile, Drone, UAV's and Other Similar Vehicles

6.5.2.1 Hazard Areas

6.5.2.1.1 Hazard areas are developed by probabilistic calculations or by maximum range capability. NOTE: The maximum range may be limited by the use of a FTS or CMS.

6.5.2.1.2 Aircraft hazard areas shall be developed for all operations.

6.5.2.1.3 A DoD ship clearance hazard area shall be developed for all impacts in the Virginia Capes (VACAPES) that meets the maximum ship impact probability of 1×10^{-6}.

6.5.2.1.4 Ship impact probability calculations shall be performed for all operations where applicable.

6.5.2.2 Range Clearance

6.5.2.2.1 WFF shall coordinate its operations with the FAA, the U. S. Navy, and other organizations, as required, to clear potential hazard areas.

6.5.2.2.2 All impacts within the VACAPES operating areas require clearance from the Fleet Area Control and Surveillance Facility (FACSFAC) prior to launch. Any part of the ship hazard area that is within VACAPES shall be surveyed for ships.

6.5.2.2.2.1 Radar and/or visual assets shall be employed for surveillance.

6.5.2.2.2.2 Other surveillance strategies, such as visual flydowns, may be employed as risk mitigation efforts.

6.5.2.2.3 Clearance with the FAA is required for any aircraft hazard area that extends beyond the VACAPES operating areas.

6.5.2.2.4 Hazard Areas for NOTAMS and NOTMARS shall be submitted 10 days prior to launch to allow for the publication of those notices.

6.5.2.2.5 Public Ship Avoidance Areas shall be submitted to WFF Public Affairs Office.

6.5.2.3 Collision Avoidance (COLA)

6.5.2.3.1 NASA shall insure that all inhabited or inhabitable spacecraft are protected from collision with sounding rocket and Expendable Launch Vehicle (ELV) motors, payloads, or other expended items that obtain a minimum apogee altitude of 200KM, including the 3 sigma high buffer.

6.5.2.3.2 All other operational satellites shall be protected with a minimum separation distance of 5KM or the Probability of Collision shall be less than 1×10^{-6}.

6.5.2.3.3 Notify the United States Strategic Command (USSC) of any upcoming launches or entry operations at least 15 days prior to operations, obtain a COLA analysis from USSC and inform USSC of any changes.

6.5.2.4 Wind Weighting

6.5.2.4.1 All unguided vehicles shall be wind weighted, except as noted in Section 6.5.2.4.2. An unguided portion of flight for guided vehicles shall also be wind weighted.

6.5.2.4.2 Low performance vehicles (i.e., test rockets) and artillery projectiles may be launched without being wind weighted, provided the effective elevation is 80degrees or less and all other safety criteria are met.

6.5.2.4.3 The operational wind weighting system shall produce solutions with errors no greater than those used to determine vehicle dispersion and potential hazard areas.

6.5.2.5 Ground Launched Vehicles without Range Safety Systems

6.5.2.5.1 The maximum effective launcher elevation setting is 85 degrees.

6.5.2.5.2 The maximum wind corrected launcher elevation setting is 86 degrees.

6.5.2.5.3 For unproven launch vehicles, the maximum effective launcher elevation setting is 80 degrees. The effective azimuth shall be chosen such that the geographical advantages of the impact area are realized.

6.5.2.5.4 For unproven launch vehicles; the maximum wind corrected launcher elevation setting is 83 degrees.

6.5.2.5.5 Surface, ballistic, and other wind limits shall be established based on vehicle wind sensitivity.

6.5.2.5.6 Effective launch azimuth and elevation settings shall be established such that the planned impact shall occur within approved operating areas.

6.5.2.5.7 Launch limitations shall be published in the Flight Safety Plan.

6.5.2.5.8 Tracking or other data sources shall be utilized to determine impacts (either during the mission or through post mission analysis) of all vehicle components.

6.5.2.6 Vehicles with Range Safety Systems

6.5.2.6.1 Launch Limitations

6.5.2.6.1.1 Flight limits shall be established to implement flight safety criteria. Examples include: impact limits, vehicle attitude, heading, time of flight, and position. These limits may be implemented as launch criteria and/or flight requirements.

6.5.2.6.1.2 Surface, ballistic, and other wind limits shall be established based on vehicle wind sensitivity.

6.5.2.6.1.3 Effective launch azimuth and elevation settings shall be established such that the planned impact shall occur within approved operating areas.

6.5.2.6.1.4 Launch limitations shall be published in the Flight Safety Plan.

6.5.2.6.2 Flight Termination Criteria

6.5.2.6.2.1 Flight termination is required when valid data shows the launch vehicle violating a flight termination boundary.

6.5.2.6.2.2 Flight termination is required when launch vehicle performance is unknown and the vehicle is capable of violating a flight termination boundary.

6.5.2.6.2.3 Orbital launch vehicles must be nominally capable of achieving a minimally acceptable orbit (~70 NM perigee) prior to orbit insertion.

6.5.2.6.2.4 Flight may be terminated as a result of gross trajectory deviation or obvious erratic flight. This action may be taken if, in the judgment of the FSO, further flight is likely to increase the hazard potential.

6.5.2.6.2.5 Other flight termination criteria may be enforced due to the uniqueness of a particular mission. These criteria shall be documented in the Flight Safety Plan.

6.5.2.6.3 Design and Test Requirements

6.5.2.6.3.1 The range safety system for rockets, missiles, UAV's and drones shall meet design and test features as specified in the RCC Standard 319-99, Flight Termination Systems Commonality Std., EWR 127-1, Range Safety Requirements, or a tailored set of requirements to meet specific hazard analysis requirements.

6.5.2.6.3.2 The range safety system for balloons shall meet the design requirements established by the CSBF.

6.5.2.6.4 Prelaunch Checks

6.5.2.6.4.1 Range safety systems for rockets, missiles, UAV's and drones shall be tested to certify the requirements in Section 6.5.2.6.3.1 are implemented.

6.5.2.6.4.2 Range safety systems for balloons shall be tested such that all requirements of the CSBF and the FAA are implemented.

6.5.2.6.4.2 Prelaunch checks shall be performed to operationally certify the range safety system.

6.5.2.6.4.3 Ground support components of the flight termination command system shall be fully redundant and operationally certified.

6.5.2.6.4.4 Operational tests shall be performed to certify that the vehicle system operates within the RF limits specified by link analysis.

6.5.2.6.4.5 A functional test shall be performed during the countdown process to certify the flight termination system.

6.5.2.6.5 Data requirements

6.5.2.6.5.1 At least two independent data systems (examples include: Radar, Optics, GPS, and IMU) are required to provide real time positional/IIP data during launch. If one of the data systems is a skin tracking radar, a ceiling limitation shall be imposed to ensure visibility until the skin tracking radar has adequate time to provide quality data. The data systems shall be designed such that no single order vehicle failure mode or ground system failure mode could cause the loss of both data systems.

6.5.2.6.5.2 Loss of data, such that the FSO cannot certify vehicle performance within flight safety limits, shall result in a flight termination action.

6.5.2.6.5.3 All data systems, which provide information used to evaluate flight safety requirements, shall be certified prior to launch.

6.5.2.6.5.4 Telemetry

6.5.2.6.5.4.1 All data systems that provide information used to evaluate range safety requirements shall undergo validation to ensure operational readiness prior to initiating any phase of flight such as launch or entry.

6.5.2.6.5.4.2 The range safety telemetry system shall provide continuous, accurate data during preflight operations and during flight.

6.5.2.6.5.4.3 The vehicle program shall coordinate with the responsible range safety organization to identify the safety data required for each flight.

6.5.2.7 Weather Constraints for Expendable Launch Vehicle (ELV) are defined in Attachment 1

6.5.3 Balloon Operations

6.5.3.1 All operations shall be conducted within flight limits, which satisfy the risk criteria stated in Section 6.2, Risk Criteria.

6.5.3.2 A predicted trajectory shall be calculated based on the prelaunch wind profile. The predicted trajectory and its descent vector shall be updated based on the current wind profile. The time of launch shall be coordinated with, and clearance to launch shall be obtained from the FAA or equivalent foreign agency.

6.5.3.3 A recovery point and time shall be selected that satisfies the risk criteria. The time and location of the recovery point shall be coordinated with, and clearance to terminate shall be obtained from the FAA or equivalent foreign agency.

6.5.3.4 A functional test of the recovery system shall be performed prior to launch to certify the range safety system.

6.5.4 Aircraft Operations

6.5.4.1 All aircraft operations managed by WFF or conducted on the WFF test range shall be performed within the requirements established by an approved Operations and Safety Directives.

6.5.4.2 All operations shall be conducted such that the risk criteria stated in Section 6.2, Risk Criteria, are satisfied.

6.5.4.3 Aircraft shall be operated in accordance with the 830-PG-7900.1, Aircraft Operations Manual and FACSFAC VACAPES Operating Instruction 31201.J or Oceanic Airspace, as applicable. Visual Meteorological Conditions (VMC) are required for all aircraft that are not Instrument Flight Rated (IFR).

6.5.4.4 For separation purposes, preassigned airspace and altitude boundaries shall be established prior to the mission for each participating aircraft. Minimum separation criteria is 1000 feet in altitude or 1 NM laterally unless formation flight is approved by the Aviation Safety Officer and a briefing with appropriate mission personnel is conducted prior to the start of the operation. Pilots shall retain the responsibility for aircraft separation; ground based coordinators shall only be used for position vectoring and advisories.

6.5.4.5 FACSFAC VACAPES shall be notified by aircraft prior to initial entry into the VACAPES area. If the aircraft is unable to notify FACSFAC, they should inform the WFF Range Control who shall notify FACSFAC.

7.0 RANGE USER AND TENANT RESPONSIBILITIES

7.0.1 Obtain approval prior to conducting any potentially hazardous operation.

7.0.2 Provide data to WFF (through the Project Manager) for safety analysis (see Section 8.0, GSFC WFF Safety Data Requirements).

7.0.3 Identify the minimum safety requirements for test operations. If a range user or tenant determines that their safety requirements are more stringent than those imposed by the WFF, the user shall coordinate these requirements (through the Project Manager) with the Safety Office.

7.0.4 Participate in discussions to familiarize FSG and GSG personnel with all aspects of the mission.

7.0.5 Participate in real time data evaluation for mission control and/or flight termination, as required by the Safety Office.

7.0.6 Notify the Project Manager of all meetings pertaining to the mission that involves safety related issues, i.e., Design Reviews, Operational Planning meetings.

7.0.7 Participate in failure/anomaly investigations and provide post flight data as required.

7.0.8 Provide a written waiver request, to the Project Manager, for any requirements specified in this document that cannot be satisfied.

8.0 WFF SAFETY DATA REQUIREMENTS

8.1 Launch Vehicle and Payload Description Data

8.1.1 Hazardous Electrical Circuits - Range users shall provide the GSFC's WFF Project Manager with two copies of schematic and wiring diagrams of all pyrotechnic and other circuits that initiate hazardous systems. The Safety Office shall be promptly notified of any changes to hazardous electrical circuits.

8.1.2 Mechanical Systems - Range users shall provide a description, including technical details and precautions, for all hazardous mechanical systems. Scale drawings shall be supplied showing the location of these and all other hazardous systems (ordnance, pressure, etc.).

8.1.3 Ordnance Devices - For each EED, data sheets shall be provided listing the minimum all fire current, maximum no-fire current, recommended firing current, normal resistance, pin-to-case resistance, and, if available, the RF sensitivity characteristics. A technical description of all SAFE/ARM type devices (out-of-line S/A, S/A connectors, mechanical restraints, etc.) employed shall be provided. For ordnance devices such as: rocket motors, shape charges, detonating cord, etc. data sheets shall be provided which identify the DoT explosive classification, normal output characteristics, composition, or any other relevant information needed to perform safety analyses.

8.1.4 Chemicals - The range user shall provide a description and schematic diagram of the system. All hardware "plumbing," components (tanks, fittings, valves), and system safety features shall be defined. An MSDS for each chemical used on the project shall also be provided.

8.1.5 Pressure Systems - The range user shall provide a description of all pressure systems used on the program. Technical characteristics, including design burst, proof, and MAWP pressures, internal volume, and materials of construction shall be provided.

8.1.6 Radiation Sources

8.1.6.1 Non-Ionizing (RF) Sources - The range user shall provide data on all non-ionizing emitters including frequency, type of emission, type of radiating antenna, and radiated power (both peak and average).

8.1.6.2.1 Ionizing Sources - The range user shall provide data on all ionizing sources as required by GPR 1860.1, Ionizing Radiation Protection.

8.1.6.3 Optical Sources - The range user shall provide data on all hazardous optical emitter (e.g., lasers) including wavelength, pulse width, pulse repetition frequency, divergence angle, and power output.

8.1.7 Ground Support Equipment (GSE) - Range users shall provide schematics, drawings, operational description, technical details, and documentation of certification for all GSE used to support hazardous systems or operations. This includes but is not limited to pyrotechnic checkout meters, breakout boxes, calibration sources, pressure systems, chemical service modules, and lifting and handling devices. This requirement is in addition to the requirements of Section 5.3.5, Ground Support Equipment (GSE).

8.2 **Operating Procedures**

8.2.1 Hazardous Systems

Detailed procedures for handling, assembly, and checkout for all hazardous systems (ordnance, mechanical, pressure, chemical, etc.) shall be provided to WFF prior to beginning operations.

8.2.2 Recovery

For recovery operations, procedures shall be provided which provide a description of the items to be recovered, reasons for recovery, hazards involved, and any recovery aids and their characteristics. These procedures shall describe the methods employed to verify that all hazardous systems are in a SAFE condition during recovery operations. A list of recovery aids such as chaff (frequency, quantity), locator beacons (frequency, power output, period of operation), dye marker (color persistence, time of deployment), flashing light (color, frequency, duration, candle power, directional characteristics), smoke (color, duration, time of deployment), radar reflective parachute (when deployed, size), or any other aids used should be included. Also, provide the desired period of recovery operations and the disposition of the recovered items.

8.2.3 Contingencies

Contingency procedures shall be provided prior to beginning operations. These contingency procedures include steps to be taken in the event of launch postponement, launch cancellation (including destaging), hold or abort, booster ignition failure, unintentional land impact, emergency response, chemical spill cleanup, or any other contingency that may endanger personnel or property.

8.2.4 Approval

All procedures for handling, assembly, and checkout of hazardous systems shall be approved by the Safety Office prior to use at WFF. Approvals shall be obtained prior to performing any potentially hazardous operation.

8.3 **Performance and Flight Worthiness Data Requirements**

8.3.1 The specifications defined in this section are intended as a synopsis for information required to perform a flight safety analysis. The actual requirements shall be mission specific. The range user is responsible for coordinating data requirements with the Safety Office.

8.3.2 Rockets, Missiles, Drones, UAV's and Other Similar Vehicles

8.3.2.1 Provide a vehicle description including a scaled drawing and operating procedures. Provide a description of the mission (i.e. Test Plan). For Drones and UAV's, provide a description of Loss of Signal (LOS) contingencies.

8.3.2.2 Nominal Trajectory Inputs

8.3.2.2.1 Launch Parameters - launcher settings, launch coordinates (WGS - 84 geodetic datum), and a sequence of events (ignitions, burnouts, separations, etc.).

8.3.2.2.2 For Drones and UAV's, supply nominal flight profile, including waypoints.

8.3.2.2.3 Other information as requested.

8.3.2.3 Trajectory Outputs

Output data may be required in printed, plotted, or computer medium format for each impacting or orbital body. The output should include:

8.3.2.3.1 Time, velocity, altitude, horizontal range, weight, thrust, drag, dynamic pressure, angle of attack, velocity vector elevation and azimuth angles, body elevation and azimuth angles, present position and instantaneous impact prediction latitude and longitude, "round earth" x, y, and z, slant range, azimuth, and elevation relative to the launcher. A Monte Carlo dispersion simulation must have a significant number of runs to reliably predict vehicle dispersion.

8.3.2.3.2 Maximum horizontal range, maximum velocity and turn rate analysis may be required.

8.3.2.4 Provide total dispersion data, either theoretical and/or empirical, in terms of one, two, and three sigma ellipses for all impacting bodies. A theoretical analysis may include some or all of the following effects: thrust offset, thrust misalignment, aerodynamic errors, uncompensated wind, launcher misalignments, weight and impulse errors, guidance and control system errors, ignition delay, and any other errors unique to this vehicle. Provide flight history trajectory data on previous vehicle flights.

8.3.2.5 Provide a debris analysis including technique and input parameters. The Safety Office may elect to perform a debris analysis. Therefore, chamber pressure and the number and type of debris fragments caused by vehicle breakup may be required. The data for each debris fragment shall include ballistic coefficient, weight, dimensions, drag coefficient, and the incremental velocity imparted by the vehicle breakup.

8.3.2.6 Provide a wind effect analysis and the method used for calculation. Provide data consistent with currently used WFF wind compensation methods. Provide parachute data, if applicable.

8.3.2.7 A Hazard Analysis could be required on critical systems, depending on the project. Identification of each potential hazard, the preventive measures to reduce each potential hazard, and a risk assessment for those potential hazards that cannot be eliminated by preventive measures should be included in the Hazard Analysis.

8.3.3 Balloons

8.3.3.1 Identify launch site and launch window.

8.3.3.2 Provide payload and balloon characteristics.

8.3.3.2.1 Provide payload dimensions and total suspended weight.

8.3.3.2.2 Provide balloon material, volume, and weight.

8.3.3.2.3 Provide gross inflation weight.

8.3.3.2.4 Provide theoretical stress index (if applicable).

8.3.3.3 Provide payload/parachute weight, drag coefficient, and reference area.

8.3.3.4 Provide the time of day (day or night) that each of the following mission phases will be performed: launch and ascent, float, descent and impact.

8.3.3.5 Provide anticipated float direction and duration of flight.

8.3.3.5.1 Provide float altitude.

8.3.3.5.2 Provide predicted float altitude variation during day/night cycle.

8.3.3.5.3 Provide float time or distance.

8.3.3.5.4 Provide float direction and estimated wind velocity at float altitude.

8.3.3.6 Provide description of any balloon control system (such as a valving system).

8.3.3.7 Provide balloon flight history data.

8.3.3.7.1 Provide balloon system reliability data including number of flights, number and types of failures, and where the failures occurred (ascent, float, or descent).

8.3.3.7.2 Provide actual and predicted payload/parachute descent vectors. Actual balloon descent vectors if available.

8.3.3.8 Provide balloon wind limitations.

8.3.4 Aircraft

8.3.4.1 The range user shall provide flight profiles including aircraft velocities, altitudes, and separations (for multiple aircraft).

8.3.4.2 Data on platform instrumentation shall be provided if it is of a hazardous nature (i.e., pressure systems, ordnance, gases, lasers, high-voltage, etc.).

8.4 Telemetry (TM) Data Requirements for Vehicles with Flight Termination

The specifications defined in this section are intended as a synopsis for pre-flight and real time data requirements. Actual requirements shall be mission specific and the range user is responsible for coordinating TM data requirements with the Safety Office.

8.4.1 Provide Command Receiver(s) signal strength (AGC) and check channel (command receiver channel 4).

8.4.2 Provide Inertial Navigation System (INS) Parameters

8.4.2.1 Provide Inertial position, velocity and acceleration. Inertial Earth Centered Earth Fixed coordinates are preferred. All reference systems shall be defined.

8.4.2.2 Provide INS initialization parameters.

8.4.3 Provide guidance commands including nozzle deflections in the pitch and yaw axes.

8.4.4 Provide vehicle attitude data including pitch, yaw and roll angles and rates.

8.4.5 Provide Motor Chamber Pressures.

8.4.6 Provide FTS.

8.4.6.1 Provide Control Circuit Status.

8.4.6.2 Provide External/Internal Battery Voltage.

8.4.6.3 Provide Safe/Arm Status.

8.4.7 Provide GPS Positional and Velocity Data.

8.5 Schedules for Providing Required Data

The specifications defined in this section are intended as a synopsis for scheduling deliverables. Actual requirements shall be mission specific and the range user is responsible for coordinating schedules with the Safety Office.

8.5.1 NASA DoD and commercial ELV's should plan to meet the schedule defined in Attachment 2.

8.5.2 For sounding rocket vehicle or payload systems not previously launched from WFF, all final data should be supplied no later than T-90 days. Preliminary data for these systems should be submitted no later than T-120 days.

8.5.3 For sounding rocket vehicle or payload systems previously launched from WFF, final data shouldl be submitted no later than T-60 days. Preliminary data for these systems shouldl be submitted no later than T-120 days.

8.5.4 For balloon systems, all final data should be supplied no later than T-30 days. If the payload contains hazardous systems, which are not covered by the general balloon Ground Safety Plan or if the launch site/operations area is not contained in the Balloon Risk Model Population Data Base, the required data should be submitted no later than T-90 days.

8.5.5 If deadlines are not met, Safety Office personnel may not be able to prepare all necessary safety plans in time to support a proposed flight. In every case, the mission shall not be conducted until adequate safety preparations are made.

8.6 Waivers

The range user shall provide a copy of any waiver for the launch vehicle or payload granted by another range.

8.7 Reviews

8.7.1 It is highly recommended that WFF Safety Office personnel participate in Design and Readiness Reviews for each mission. The Range User should notify Safety Office personnel through the WFF Project Manager at least ten days prior to conducting such reviews. Safety participation in such reviews may prevent costly engineering changes and scheduling delays.

8.7.2 Should WFF not be represented at Design and Mission Readiness Reviews, a copy of the review material shall be submitted to WFF as early as possible following the review.

ATTACHMENT 1

WEATHER CONSTRAINTS FOR
EXPENDABLE LAUNCH VEHICLE (ELV)

The RSO must have clear and convincing evidence the following constraints are not violated.

1. Do not launch if any type of lightning is detected within 10 NM of the launch site or planned flight path within 30 minutes prior to launch, unless the meteorological condition that produced the lightning has moved more than 10 NM away from the launch site or planned flight path.

2. Do not launch if the planned flight path will carry the vehicle:

   a. through cumulus clouds with tops higher than the +5 degrees Celsius level; or

   b through or within 5 NM of cumulus clouds with tops higher than the -10 degrees Celsius level; or

   c through or within 10 NM of cumulus clouds with tops higher than the -20 degrees Celsius level; or

   d through or within 10 NM of the nearest edge of any cumulonimbus or thunderstorm cloud including its associated anvil.

3. Do not launch if at any time during the 15 minutes prior to launch time the one minute average of absolute electric field intensity at the ground exceeds 1 kilovolt per meter (1 kV/m) within 5 NM of the launch site unless:

   a there are no clouds within 10 NM of the launch site; and

   b smoke or ground fog is clearly causing abnormal readings.

4. Do not launch if the planned flight path is through a vertically continuous layer of clouds with an overall depth of 4,500 feet or greater where any part of the clouds are located between the 0 degrees Celsius and the -20 Degrees Celsius temperature levels.

5. Do not launch if the planned flight path is through any cloud types that extend to altitudes at or above the 0 degrees Celsius level and that are associated with <u>disturbed</u> weather within 5 NM of the flight path.

   DEFINITION: Disturbed weather is any meteorological phenomenon that is producing moderate or greater precipitation.

6. Do not launch through thunderstorm debris clouds, or within 5 NM of thunderstorm debris clouds not monitored by a field mill network or producing radar returns greater than or equal to 10DBz.

   DEFINITION: Debris Cloud is any cloud layer other than a thin fibrous layer that has become detached from the parent cumulonimbus within 3 hours before launch.

<u>GOOD SENSE RULE:</u> Even when constraints are not violated, if any other hazardous weather conditions exist, the RSO may hold at any time based on the instability of the weather.

ATTACHMENT 2

DATA REQUIREMENTS AND
REVIEW SCHEDULE

TIME	**EVENT**	**PURPOSE**	**POC**	**INPUT**	**OUTPUT**
Initiation of Project	Mission Initiation Conference (MIC)	Define Mission Objectives	WFF PM Program Manager Mission Manager Launch Vehicle Manager	(1) Description of Payload & Proposed Orbit (2) Project Team presentations	MIC minutes and action items
Prior to Payload PDR	Safety TIM's	Address Specific Safety Issues	WFF PM Mission Manager Launch Vehicle Manager	Formal presentation of issues by project team & WFF Range Safety	-TIM minutes -Project status memo -Action items resolution
NLT L-18 months	P/L PDR	Define System preliminary Hazard Analysis (PHA)		Project Team provides: -Preliminary Safety Analysis -Hazard Analysis -P/L Design Docs & Dwgs -Special Ops -Preliminary Trajectory	
PDR +60 days	Preliminary Safety Data Package (SDP)	User provides Preliminary Safety Document for Vehicle, P/L and Special Ops	WFF PM Mission Manager Launch Vehicle Manager	Project provides: -Preliminary Safety Data for Safety Plan Development	SDP for review
PDR + 60 days	Safety TIMS	Discuss SDP	WFF PM Mission Manager Launch Vehicle Manager	Project Team presents: -Trajectory Data -Safety Analyses -Facility Mods -Prelim Operations Plan	TIM Minutes Status Resolution Action Items

TIME	EVENT	PURPOSE	POC	INPUT	OUTPUT
NLT L-12 months	P/L CRD	Finalize Design	WFF PM Mission Manager Launch Vehicle Manager System Experts	Project Team presents Final P/L design	Preliminary Safety Approval (subsystem) Final Hazard Analysis
	Safety TIMS	Resolve Action Items and Safety Issues	WFF PM Mission Manager Launch Vehicle Manager	Project Team Identifies: - Design changes -Operational methods -Testing	TIM Minutes documenting resolution of issues
CDR +60 days	Operational Support System TIMS	Define Operational Support	WFF PM Mission Mgr. Launch Vehicle Manager Mission Ops Manager	Project Team presents Mission Operation (data) requirements WFF Safety presents: Real Time Data requirements	RF Link Analysis Mission Support Allocation
L-75 Days	Final SDP	User provides Final Safety document for Vehicle, P/L, and Operations	WFF PM Mission Manager Launch Vehicle Manager	Project provides Final Safety Data for safety plan development	Approved SDP
L-75 Days	Final Hazard Procedures Submittal	User submits to Range final procedures for all hazardous operations	WFF PM Mission Manager Launch Vehicle Manager	Project provides procedures for hazardous operations	Proposed Hazardous Operations Procedures Document
L-75 days	System Safety A/I Resolution Meeting	Attempt to close out safety action items	WFF PM Mission Manager Launch Vehicle Manager	Project team and WFF safety resolve all action items	Action Item close-out document

TIME	EVENT	PURPOSE	POC	INPUT	OUTPUT
NLT L-60 days	Final Trajectory Tape to WFF (including a test Telemetry Tape)	Project delivers final trajectory tape to WFF	WFF PM Mission Manager Launch Vehicle Manager	Project provides Trajectory data tape and inputs to WFF	Final Trajectory Tape (Required for Flight Plan Approval)
L-60 days	Final Flight Plan Submittal	Project delivers final Flight Plan for Aircraft Operations	WFF PM Mission Manager	Project provides Final A/C Ops Plan	Final Flight Plan
L-45 days	Operational Procedures Approval	Internal WFF approval of Operation Procedures	WFF PM	WFF provides letter approving hazardous operation procedures	Formal statement from WFF identifying approved procedures
L-30 days	Mission Safety Review	Closure of all Safety Action Items Definition of Safety Status	WFF PM WFF Safety Mission Manager Launch Vehicle Manager	Final Closure of Action Items by Project Team and WFF	Memo documenting Mission Safety Readiness
L-21 days	OSD	Define Operational Safety Plan Flight Safety Plan Ground Safety Plan GO/NO-GO Items	WFF participating organizations	WFF provides: -Flight Safety Plan -Ground Safety Plan -GO/NO-GO Items OSD defines: -Requirements Test Directives -Air Ops Plan	OSD
L-21 days	FTS Certification	Test Plan & documentation for FTS	WFF Safety Launch Vehicle Manager	WFF defines FTS certification documents	FTS test plan and document
L-14 days	Mission/Range Readiness Review	Determine readiness of range, P/L, vehicle and supporting sites	WFF PM	Readiness Status	Readiness Status
L-5 days	Flight Readiness Review	Determine readiness of support A/C	WFF PM	Readiness Status	Readiness Status
L-2 days	Launch Readiness Review	Review all prelaunch testing and certification	WFF PM	Results of prelaunch testing and certification	Launch Readiness Certification
	LAUNCH				

CHANGE HISTORY LOG		
REVISION	EFFECTIVE DATE	DESCRIPTION OF CHANGES
Baseline	June 28 2002	Replaces RSM-93 dated June 23, 1993
A		Updated GDMS document numbers (Section 4). Updated to include NPR 8715.5 NASA Range Safety Program requirements (Section 6)